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THE EQUIPMENT AND MANAGEMENT OF STEAM BOILERS.

IN a paper read before the National Electric Light Association of America, Mr. A. A. Cary deals with steam boiler purchase as well as their equipment. He is of opinion, and we cordially endorse his opinion, that steam users, who have as a rule quite as much as they can do in looking after their own business, are far too apt to consider themselves capable of choosing their own boilers, and despise the services of an outside consulting engineer, who could, as a rule, save for his clients far more than his fees would amount to. But nine out of ten manufacturers consider that they are *au fait* with boilers because they use them in their business, and as Mr. Cary says, he finds men who are bright, practical, and mechanical in their own business, who believe that they are equally good in their engineering knowledge, with the result that their steam plant is often in a state which is anything but economical. We have sometimes wondered how a cornmiller would deal with an engineer who, on the ground that he had a powerful appetite for bread, presumed to instruct the miller in the details of grinding wheat and mixing the qualities or humidifying, yet engineers are daily recipients of this kind of thing at the hands of steam users, whose use of steam no more makes engine or boiler specialists of them than the eating of food makes a man a miller or a farmer, or living in a house a bricklayer.

These plants, model ones in their owners' eyes, are the smoke-makers and coal-wasters, where a guess is made at the power being developed, and the coal consumption is made to look small, and there is no account kept of water consumption. In recommending steam users to employ experts to assist them and advise them in the choice of boilers, he specially draws the line at the expert who has but one boiler, and uses this in and out of season. He might have had in his mind the average English electrical engineer, whose narrowness could not allow him to use anything but water-tube boilers, and whose advocacy of this type has been so pronounced as to lead to a considerable crusade from the advocates of other forms of boiler, and to statements from them that may in time grow almost as extravagant as those made by the water-tube men. Mr. Cary cites as an example requiring thought, and not blind advocacy, the case of a long line of rolls driven by a large reversing engine. Such an engine will usually have a large cylinder and a small stroke, and will often be found gulping steam at the rate of 50 lbs. per H.P. hour. These engines are started up with full load on, and take steam the entire stroke, and make for a short time an enormous demand on the boiler for steam. How is this demand to be met? In several ways; first, by a boiler with an abnormally large steam space; secondly, by means of a large water capacity; thirdly, by what is the same, thermal storage; and, fourthly, by a high pressure boiler giving steam through a reducing valve.

The duty of the expert is to balance these requirements in a proper degree, and provide a boiler which will do the work and give out a large power without undue loss of pressure, and absorb the heat of the furnace without loss of steam at the safety valve when the engine is stopped. Obviously a water tube boiler is unsuited to such a case. Then, again, we might cite the Lancashire boiler, which, with its great length, is quite unsuited to many places, for one would not care to make this boiler less than three diameters long. The marine boiler comes in here, and can be used where the Lancashire boiler is too long; but the marine boiler is apt to make a hot boiler room, the shell being so exposed, and no matter what type may be selected, there are conditions at every place which call for the use of a particular type of boiler by preference.

As a matter of fact, the difference in the performance of different boilers is far from marked under similar and equally advantageous conditions, and not much reliance is to be placed on the claims made by different agents for great economies and other advantages. The truth is that the special advocates are far too apt to lay weight on some special feature, to the exclusion of all others, as though there were salvation in grate area or tube length, or some other detail quite apart from the general balance and arrangement of parts. We have heard of weight being held forth as a particular virtue in a boiler, and have even seen a cylindrical shell boiler fitted with transverse bar stays to strengthen it against bursting. Ridiculous as this appears, there are other equally ridiculous things done for the too learned steam user.

An Examination of Peroxide Electrodes.

A Considerable amount of interest has centered round the peroxides in connection with polarisation and its prevention during the last few years, and now and again extraordinary merits have been claimed for some of them, hence the subject appears to have been sufficiently interesting to suggest an investigation to O. F. Tower; and in a recent issue of the *Zeitschrift für Physikalische Chemie* (Volume xviii., page 17), he gave results of his experiments. Without following him through the means by which he attained these results, we may, however, notice the chief of them, since they are of considerable importance. His first conclusion is, that lead, silver, and thallium, peroxides are unavailable, since with the first a considerable time is necessary before a constant E.M.F. is obtained, whilst the other two are unstable and readily acted on by dilute acid solutions. Manganese peroxide, being free from the above disadvantages, was therefore selected for the experiments. The E.M.F., with this electrode, is given by the formula

$$n e_o \pi = R t \log (c_m c_o^4 / c_m' c_o^4),$$

where $c_m + c_o$ are the concentrations of the manganese and hydroxyl ions respectively, the other letters having the usual significance. In acid solutions $c_o \times c_H$ being constant, k/c_H may be substituted for c_o, and the formula reduces to

$$\pi = -0{\cdot}0286 \log (c_m c_H^4 / c_m' c_H^4).$$

Experiments were made with solutions of nitric acid and manganous nitrate; the observed and calculated results show satisfactory agreement, the differences being probably due to incomplete dissociation. As theoretically indicated, the effect of the salt concentration was found to be four times that of the acid. Experiments were also made with phosphoric, malonic, tartaric, formic, acetic, salicylic, orthamidobenzoic, mono-, di-, and tri-chloracetic acids, the concordance between the observed and calculated numbers being again, for the most part, satisfactory. The influence of temperature was next determined. This, in the case of nitric and sulphuric acids, is very slight, rather more for phosphoric and the chloracetic acids, and very marked with acetic, formic, and tartaric acids. No reason for these differences is, however, indicated. The determination of the E.M.F. is also employed for the determination of the degree of dissociation of the sodium salts of 16 organic acids at varying concentrations, and the results, compared with those obtained by Trevor, *Zeitschrift für Physikalische Chemie*, Volume x., page 321). The only cases in which satisfactory agreement is not obtained are those of the phthalates and isophthalates, where the author finds the former salt to be the more highly dissociated. Barium salts were also employed in a few cases, and the dissociation is determined for acid-sulphates of potassium, magnesium, sodium, aluminium, and copper, hydrogen, sodium, selenate, and dihydrogen sodium phosphate. In alkaline solutions, the electrolyte is a solution of $Mn(OH)_2$, hence $c_m \times c_o^2 = k$, and $c_m c_o^4 k/c_o^2$, hence $0{\cdot}0286 \log (c_o^2 c_o^2)$. The availability of the formula is shown by experiments with potassium, sodium, barium, strontium, calcium, and ammonium hydroxides. By the use of a perfectly neutral solution, the dissociation of pure water is obtained as $4{\cdot}4 \times 10^{-8}$, a number which, although of the same degree of magnitude, is smaller than that which has been obtained by other methods.

The Pull of a Horse.

From the letter of Mr. A. L. Steavenson, which appeared in our issue of July 10th, it would appear that a powerful horse may do work for a short time at the rate of nearly six mechanical horse-power upon a draw-bar dynamometer, and that probably tram horses exert nearly four horse-power at their maximum. Morin, again, found that a little over 5 H.P. overstrained the horses even when of short duration. Still, it is evident that tramcars when started from rest and accelerated are absorbing three to four times the work which a horse can continuously perform. Indeed, Watt's determination of the mechanical horse-power was avowedly 50 per cent. in excess of what an average horse could perform for several hours, and as the average horse was, we believe, the London dray horse, of more powerful build than the tram horse, it need cause no surprise that when mechanical means are set to traction work there should be required a power much in excess of what at first sight might be supposed necessary. Unfortunately the connection of a motor to the driving wheels is not sufficiently variable in speed ratio to permit of the motor being run at a speed sufficient to give great power, and with this and other reasons acting, it has come to pass that modern cars are supplied with a large nominal excess of power. The first excess is demanded by the fact that the horse exerts several horse-power at times of starting, and the second excess arises from the loss of nominal power which occurs with a motor when running slowly. Conjoined they seemed to establish a good reason for the large powers now demanded, and needless to say the further demand for rapid starting will increase even these large powers. This latter, however, will scarcely be found outside the field of the public vehicle. It should scarcely apply to the light private car.

Horseless Carriage Bill.—This Bill was considered by the Standing Committee on Law on Monday last, and it was agreed that the maximum unladen weight of light locomotives should be three instead of four tons, not including the weight of water, fuel, or accumulators used for propelling the vehicle.

OBITUARY.

Sir John Pender, G.C.M.G.

Our "cable king" has left us. How this came about, preceded by illness of six months' duration, the daily press has already narrated. We have therefore only to do here with his life. What we mean by the "nineteenth century" really began with Waterloo, and John Pender was born in the Waterloo year. Any life thus co-extensive with such a century could scarcely fail to be interesting, provided it were the life of a shrewd, observant man, as Sir John Pender was; but his is especially notable, in that—as all the world knows—it was bound up with the rise, struggles, and triumph of ocean telegraphy.

Young Pender's early history gave promise of great practical ability and an intelligent spirit of enterprise, though at first it had nothing to do with the application of electricity. Well educated, and early put forward into business life, he became the general manager of a factory in Glasgow when little more than 20 years of age, and soon after enjoyed the reputation of being a highly successful merchant (in textile fabrics) both at Glasgow and Manchester.

John Pender's first association with things telegraphic took place when he became a shareholder, and eventually joined the board, of the Magnetic Telegraph Company soon after its formation.

From this it was only natural that so enterprising a spirit should become interested in the Atlantic cable project; for when Cyrus Field failed to raise the necessary capital in his own country, and had come over here, the amount was got together by John Watkins Brett and Edward Bright, mainly amongst the shareholders of the "Magnetic" Company, by subscription lists being opened in Liverpool, Manchester, Glasgow and London. In a few days the £350,000 was raised by the issue of 350 shares of £1,000 each. Mr. Pender was one of these shareholders.

The story of the first Atlantic cable, how it was successfully laid by H.M.S. *Agamemnon* and U.S.N.S. *Niagara* ultimately in 1858, under the engineership of Sir Charles Bright, and how the *Agamemnon* was nearly wrecked in her passage, is not necessary to dwell upon here. It suffices to say that, after six weeks' useful, but slow working, the cable failed, partly owing to lack of experience in core and joint construction, but still more owing to the excessive electromotive force employed for the too small conductor in accordance with the views of Faraday and Whitehouse, the electrician, but not with those of Prof. Thomson (now Lord Kelvin), Mr. (afterwards Sir Charles) Bright, Mr. S. A. Varley, or of others.

However, just as the original promoters—Mr. Cyrus Field, Mr. J. W. Brett, and Sir Charles Bright—were not in any way daunted by their failure in 1857, neither was this failure sufficient to make certain people relinquish the project entirely, for in 1864 a fresh attempt to raise capital for a new cable was made by Field—Mr. J. W. Brett having died in the interval, and Sir Charles Bright being in India. It is doubtful whether Field would have succeeded but for Pender's strong support.

The 1865 expedition proving a failure, another new cable was ultimately laid by the *Great Eastern* (Captain, afterwards Sir James, Anderson) in the following year (just 30 years ago), Sir Samuel Canning (then Mr. Canning) being in engineering charge on behalf of Messrs. Glass & Elliot, the contractors, and Mr. Henry Clifford being the second member of the staff. This line, be it remarked, would very likely never have been established but for the subject of our obituary; or, at any rate, not for some years later. The manufacturers of the core, the Gutta-Percha Company, wishing to see their prospects of a return to the extent of a quarter of a million, Pender came forward with a personal guarantee for this amount, and soon afterwards this company was amalgamated with Messrs. Glass, Elliot & Co., the contractors for the cable manufacture, under the title of the Telegraph Construction and Maintenance Company, of which Mr. John Pender became the first chairman. About the same time the Atlantic Telegraph Company, having come to financial grief, was practically replaced by the then newly formed Anglo-American Telegraph Company.

The ultimate success attending this venture gave rise to a new era in submarine telegraphy. The period of first attempts was virtually over.

In 1868 the Anglo-Mediterranean Telegraph Company was formed for the purpose of establishing fresh communication between Malta and Alexandria by means of a direct, deep-water, cable. The new line was effected with complete success. The Telegraph Construction Company were the contractors, with Sir Samuel Canning and Mr. Willoughby Smith respectively as their chief engineer and electrician; whilst Sir Charles Bright acted both as engineer and electrician to the Anglo-Mediterranean Company. Financially speaking, Mr. Pender was the prime mover in this enterprise; and this cable afterwards formed the nucleus of that vast system of the world's metallic nerves to the East and Far West—with a trunk line to India—owned by what is now known as the "Eastern" and "Eastern Extension" Telegraph Companies.

In 1869, France was put into direct telegraphic communication with America. This cable was partly manufactured by the Telegraph Construction Company and partly by the late Mr. W. T. Henley, but the Telegraph Construction and Maintenance Company were the contractors for the laying of the entire length. This scheme, though mainly on behalf of France and the rest of the European Continent, was principally advanced by British financiers; moreover, the working of the cable was chiefly under British direction and management. In this connection John Pender was again prominently to the fore, as one of the leading financial spirits.

Another long and important length of cable, made and laid by the Telegraph Construction Company in the same year (1869), was a direct cable for the British Indian Submarine Telegraph Company. This was the outcome of the Anglo-Indian Telegraph Company, which had acquired the Egyptian landing rights previously granted to the Red Sea Company, but which had failed to raise the capital required for their scheme of establishing direct telegraphic communication to India by means of submarine cables, instead of landlines as far as the Persian Gulf. Sir Charles Bright, M.P., and Mr. Latimer Clark were the engineers for this project, whilst Mr. H. C. Forde went out on the ultimate expedition in a similar capacity. The cable was laid between Suez and Bombay, down the Red Sea, touching at Aden, and thence across the Arabian Sea.

Following this came the extensions eventually to China for the British-Indian extension and the China Submarine Telegraph Companies, effected entirely by the Telegraph Construction and Maintenance Company under the guidance of John Pender, Sir C. Bright being the engineer to the company. In 1872 the first cable was laid from India to Australia for the British-Indian-Australian Telegraph Company, *via* the Straits settlements. This, again, was mainly due to the enterprise evinced by the subject of our obituary.

It was about this time that the Marseilles, Algiers and Malta Telegraph Company was promoted for the purposes of a cable between France and Malta, touching at Bona, on the north coast of Africa, and this project was similarly carried out under the same influence.

A few months later the Falmouth, Gibraltar and Malta Telegraph Company was formed by similar hands, with a view to thus actually completing direct submarine telegraphic communication between Great Britain and her Eastern possessions, the cable being eventually taken into Lisbon, in response to the special advances of the Portuguese Government.

It is worthy of note that none of these companies were assisted by any government, monopolies, subsidies, or guarantees, as in the case of the original Red Sea cables; so that it may truly be said that the Government and mercantile communities of the world owe the vast benefits that they have received from direct submarine telegraphic communication during the past 25 years, entirely to the enterprise of a few British merchants, and to the original shareholders in these companies (and individually to none more than John Pender), who risked their capital in an undertaking which, at the time, appeared to be a speculation of a most uncertain character, though naturally they did so principally with a view to benefiting themselves.

It may be inadvertently remarked that all these companies were floated just after the Telegraphs Purchase Bill of 1868

had been passed. It was no doubt thought by those promoting these cable companies that it was a particularly opportune moment for endeavouring to secure some of the capital which had previously been invested in similar undertakings, *i.e.*, in the Electric, Magnetic, United Kingdom, Reuter, or other Telegraph Companies, which had, up to date, shared the control of the land telegraphs of the United Kingdom. On the taking over of these lines by the State, something like eight millions sterling, was, in fact, let loose for re-investment, mainly from the "Electric" and "Magnetic" companies.

Mr. Pender, as a large "Magnetic" shareholder, no doubt quickly foresaw the opening that was made for further telegraphic enterprise on this account. Moreover, just after the success of the Atlantic cable, financiers and capitalists were each emboldened to float, and invest in, fresh concerns of the same character; in fact, to attempt further extensions.

In 1872, the four companies owning the cables on the direct route to India, and already referred to, were amalgamated into the now world-famous Eastern Telegraph Company. This company, comprising by far the largest telegraphic system of the present day—and from a national point of view the most important at present—was more especially promoted by John Pender, who became the chairman, with Lord William Hay (now Marquis of Tweeddale) as vice-chairman.

This having been successfully accomplished, in the following year (1873) the Eastern Extension, Australasia, and China Telegraph Company was formed for absorbing those companies—previously enumerated—which had owned the extension lines to the further side of India, the Straits settlements, China and Australia, as already described. Pender similarly took the leading part in this transaction. An important extension in this company's system was carried out in 1876 by a cable being laid between Australia and New Zealand.

In 1873 the Brazilian Submarine Telegraph Company was established. This company had for its object the promotion of telegraphic communication with Brazil and the rest of the South American Continent, to work in unison with the Western and Brazilian Company, floated in the same year. Again, at the same time, the Direct United States Cable Company became a *fait accompli*, and had a cable laid for them by Messrs. Siemens Bros. Sir John Pender was closely connected with both these enterprises, and was, in fact, their chairman up to the day of his death.

In 1873, Mr. Pender and other promoters of the principal allied telegraph companies formed the Globe Telegraph and Trust Company. This was intended to provide the public with a means of investing their money in submarine telegraphs in such a way as to avoid risk in investment by fluctuation of the value of shares in any particular company at any particular moment. The Submarine Cables Trust, of which Sir John was a trustee, had been formed a short time previously with the same object and similar promoters, but dealing only, as it still does, with three or four of the largest telegraph companies shares.

Other lines followed to the Cape (along both coasts of Africa in 1879 and 1889 respectively) and elsewhere, all of which were, either as regards inception, promotion, and financing, first due to John Pender and his confederates, or else have since fallen into their hands.

Practically all these lines have since been duplicated; and in some instances triplicated or even quadrupled. The further ensurance of these extensions formed a part of the policy of Sir John Pender, and were in each instance carried out by the Telegraph Construction Company, with Messrs. Clark, Forde & Taylor as engineers to the companies concerned.

In dealing with the life of John Pender from an engineer's point of view, we have practically run through the history of submarine telegraphy, and especially as regards the early pioneering work in the fifties and sixties.

The total length of cable for telegraphic purposes sunk (but not lost) at the bottom of the sea, up to the present time, is about 160,000 nautical miles, representing, in the form of productive capital, nearly 50 millions sterling. Of this, about 90 per cent. has been provided by private enterprise (mainly due to John Pender) and 10 per cent. by the various Governments.

The Eastern and allied companies, as promoted by John Pender, form by far the largest submarine telegraph system, owning over 50,000 miles of cable, representing a capital of over £10,000; and if other more distantly allied companies be included, it will be found that the capital involved forms about a third of the entire submarine telegraph system. The present total market value is, of course, much in excess of this figure. Thus, the shares of the Eastern Telegraph Company (by far the largest individual concern in telegraphs) are to-day worth 50 per cent. more than their original value—in itself highly suggestive of good management and organisation.

We now see what John Pender has done for his country—indeed, for the world, as well as for himself and his family—in the promotion and organisation of submarine telegraphy. To our mind, he has done even more than Cyrus Field, in the actual pioneering work alone, looking at both in the light of telegraph financiers, but not as engineers (as some of our daily contemporaries appear to have done, in omitting all reference to those engaged for the practical realisation of the early schemes). It must be remembered that neither capital nor science can work usefully in this direction—as in other directions—without each other. Just as the engineer is dependent on the capitalist, so also is the capitalist dependent on the engineer for carrying out his scheme. Sir John Pender never failed to recognise this and, with a strong sense of judgment, was able to command the best possible technical advice.

At the hour of death Sir John Pender was chairman of ten different telegraph companies, which it is unnecessary to enumerate, representing at the present day a capital of somewhere about 15 millions, and a mileage of nearly 75,000.

Not limiting himself to things telegraphic, this indefatigable worker and organiser, turned his attention to electric lighting when within the range of practice; he was chairman of the Metropolitan Electric Supply Company, which maintained last year upwards of a quarter of a million of lights, and is, in fact, the largest undertaking of its kind in this country.

With John Pender as a legislator we have nothing to do. It suffices to say that, as a man of affairs, it was only natural that he should hold a seat in Parliament, as he did almost continuously since 1865.

John Pender was always a firm advocate of technical education, and promoted its cause in various ways.

The daily Press has already dealt at length with his various social qualifications, including that of an art patron on an extensive scale.

In 1888, John Pender was made a K.C.M.G., in recognition of his services to the Colonies and to the British Empire at large by the extension of submarine telegraphy. Four years later, Sir John was promoted to a "Grand Cross" of this distinguished order.

Besides this, various foreign countries decorated him with some of their highest orders.

Again, science is said to have recognised his services by electing him a Fellow of the Royal Society, both of London and Edinburgh, as it has in various notable instances recognised the services of others for indirect, but no less forcible, reasons.

To say that any man is irreplaceable is, probably, always an exaggeration; but certainly it is difficult to call to mind any living man who can bring the same amount of indomitable energy and foresight to the helm—financially speaking—of submarine telegraphy.

There are but few of the early pioneers left, now, in submarine telegraphic matters. On the financial side, John Watkins Brett, Cyrus W. Field, Sir James Carmichael, Sir James Anderson, and Sir John Pender are no more; whilst on the technical side we have lost C. V. Walker, T. R. Crampton, Sir Charles Bright, Wildman Whitehouse, W. Reid, R. S. Newall, Werner Siemens, Sir William Siemens, Edwin Clark, C. F. Varley, Willoughby Smith, Fleeming Jenkin, J. C. Laws, and Charles Hockin.

We still have with us Jacob Brett, C. Wollaston, Lord Kelvin, Sir Samuel Canning, Latimer Clark, F. C. Webb, Henry Clifford, S. A. Varley, Edward Bright, H. C. Forde, W. H. Preece, H. A. C. Saunders, and, perhaps, a few others, all of whom live to deplore the death of Sir John Pender, and sum up the past.

THE ELECTRO-METALLURGY OF ALUMINIUM: SOME POSSIBILITIES DEDUCED FROM THEORETICAL AND PRACTICAL CONSIDERATIONS.

In the May issue of the *Journal* of the Franklin Institute, there is a paper by Dr. J. W. Richards, which should be studied by all those who are interested in electro-metallurgy, for the author is a recognised expert in this branch of knowledge in the United States. The early part of the paper is concerned with definitions, and is more or less of the text-book order, the electro-metallurgy of aluminium is then considered.

Dr. Richards enumerates the various native minerals which may be considered as the available ores of aluminium; these are—bauxite, cryolite, kaolin, and the native alums. Their properties and relative values, as sources of aluminium, are carefully stated. Then follow the various chemical compounds of aluminium which may be considered available for use in electric processes, and which may be formed by chemical processes from the ores, and then used as intermediate products. These are aluminium chloride, aluminium chloride with alkaline chloride, aluminium fluoride, aluminium fluoride with alkaline or alkaline-earth fluorides, alkaline aluminates, metallic aluminates, aluminium phosphate, aluminium borate, aluminium nitrate and acetate, aluminium sulphide, aluminium sulphide with alkaline sulphides. The various advantages and disadvantages of these substances are carefully pointed out.

Dr. Richards then proceeds to consider the electric processes, and this will doubtless be found to be the most interesting part of his paper.

I.—The Electrolysis of Aqueous Solutions.

1. Refining the crude metal.

The question of thus refining impure aluminium to a high standard of purity is one to which very little attention has so far been given. Since the solution of metal at the anode balances its deposition at the cathode, no voltage is absorbed in electric decomposition; potential is needed only to overcome the conductive resistance of the electrolyte, and the water need not therefore be decomposed. The difficulty is to deposit the molecules of metal more rapidly upon the cathode than they can be oxidised by the water, and so prevent the deposit being changed into aluminium; but it is met by using a current of large quantity per unit of depositing surface. It is within the range of possibility that at some future time we may see impure aluminium being refined on these lines, just as copper is now treated. Dr. Richards quotes experiments which support this expectation.

2. An ore of aluminium replaces the soluble aluminium anodes. No successful process has yet been developed on these lines; but it is by no means beyond the range of possibility. These ores are all non-conductors; but imagine them mixed in with the substance of a carbon anode, so that the composite anode, on being attacked by the liberated acid ingredient of the electrolyte, reforms the aluminium salt which was decomposed, and thus regenerates the solution. The voltage required for decomposition, in this case, would be practically that required to decompose the aluminium compound in the anode, and if this compound were an oxygen compound of aluminium, would require 2·8 volts, thus entailing the simultaneous decomposition of the water (which requires 1·49 volts), and a corresponding loss of power. Such a process is theoretically possible, though as far as can be judged at present, practically difficult.

3 (*a*). Instead of the ore, the use of some aluminium compound made from the ores, which would be a good conductor. This would be particularly good, if it should be possible to find a compound requiring less than 1·49 volt to decompose it. Perhaps the double alkaline sulphides come the nearest of any in this respect; but doubtless other compounds will be found more closely approximating to the desirable properties. The voltage required for such salts is only 0·9, and they may possibly be conductors, to some extent, and stable in water. Our knowledge in this direction is at present very meagre.

3 (*b*). The use of soluble anodes of another cheaper metal, placed in porous cells, to prevent their salts from mixing with the aluminium salt around the cathode.

The voltage required for decomposition in this case is only the difference between that required to decompose the aluminium salt, and that which would be required to decompose the corresponding salt of the other metal, which latter voltage represents the counter E.M.F. obtained by the solution of the anode. It would apparently not be a very difficult step to extract the aluminium directly from a solution of its salt, using zinc, or possibly iron, for the soluble anode, and keeping the different salts apart by porous partitions. Theory indicates such a process as being within the range of possibility.

II.—The Electrolysis of Fused Compounds.

1. Refining of crude metal.

It is quite conceivable that, by the use of some of the good conducting double chlorides or double fluorides of aluminium and the alkaline metals, which melt below the fusing point of aluminium, the refining of the crude metal, using it as the anodes, might be practised successfully. This line of work offers great inducements for investigation, since by the present methods of extraction, impure aluminium can be produced direct from the ores more cheaply than the pure metal. The margin is large enough to suggest that a suitable refining process should find a place in the industry.

2. The only fusible ore of aluminium now known, which is available for direct electrolysis, is cryolite. If melted and electrolysed with an insoluble anode, aluminium is separated, and fluorine set free, while the composition of the bath is gradually changed by the elimination of aluminium fluoride, leaving it relatively richer in sodium fluoride, until at last sodium is set free, and the bath practically stops working. The method of working cannot be practised commercially, for several very evident reasons. This class of process may be said to be practically inoperative, in spite of Dr. Kleiner's experiments, and to offer very little, if any, inducement to the investigator.

3 (*a*). Converting the ore into some fusible compound, and then electrolysing. This heading brings us to the original process, by which Deville and Bunsen first made aluminium *en masse*. Aluminium-sodium double chloride was electrolysed, and the metal obtained. The process is imperfect; but if Deville had had dynamos at his command, it might have been developed by him into a cheaper method than his sodium process. Quite recently the idea has been advanced of converting the ore into the fusible double sulphide of aluminium, and an alkali metal, and electrolysing this compound. This salt is more cheaply prepared, is very stable in the air, and requires less than 1 volt to decompose it. Other salts of this kind will probably be discovered, and perhaps made available in the industry.

3 (*b*). Dissolving the ore in a fused salt which acts as a solvent, and then electrolysing.

This division of electro-metallurgical processes contains the only methods by which commercial aluminium is at present being produced.

In the process as at present practised, the solvent bath is composed of the double fluorides of aluminium and sodium. This bath may be simply cryolite, but preferably cryolite to which has been added a further proportion of aluminium fluoride and a little fluorspar. Into this bath is stirred pure alumina, made from ore by a chemical process, and which is dissolved by the bath to the extent of one-fifth of its weight. The electric current is then sent through this mixture, using for anodes carbon rods dipping into the bath from above. The cathode is formed by the carbon lining of the vessel, on the bottom of which the melted aluminium collects, when the dissolved alumina has nearly all been removed, the resistance of the bath rises, and fluorine fumes from the decomposition of the solvent begin to appear; fresh alumina is then stirred in, and the operation thus proceeds continuously. Dr. Richards gives illustrations and a description of the manufacture of aluminium by the Hall process as worked by the Pittsburgh Reduction Company at New Kensington, Pa., U.S.A., and also at Niagara Falls, by the Aluminium Industrie Actien-Gesellschaft at the Falls of the Rhine (the Héroult process) Neuhausen, Switzerland, by the Société Electro-Metallurgique Française at La Praz, Savoy (Héroult process). The Société Industrielle de l'Aluminium at Saint-Michel (Savoy (Hall process). The British Aluminium Company, at Larne Harbour, Ireland, and the Falls of Foyers, Scotland (Héroult process), &c.

A tabular statement of the aluminium works now in operation, their power and daily capacity, is as follows:—

	Horse-power.	Daily capacity, pounds.
United States:—		
New Kensington, Pa.	1,600	2,000
Niagara Falls, N.Y.	1,600	2,400
Switzerland:—		
Rhine Falls	4,000	5,000
France:—		
La Praz	2,500	3,000
Saint Michel	2,000	2,500
Total	11,700	14,900

This tabulation exhibits a present capacity of 2,500 tons per year; the production during 1895 was approximately 1,500 tons.

The enlargements and new plants at present projected, and which will probably be in operation in 1897, or by 1898 at the latest, are as follows:—

	Horse-power.	Daily capacity, pounds.
United States:—		
Niagara Falls, N.Y.	5,500	7,000
Switzerland:—		
Rheinfelden	6,000	8,000
France:—		
Saint Michel	2,000	2,500
Great Britain:—		
Falls of Foyers	3,000	4,000
Norway:—		
Falls of Sarpsfos	5,000	6,500
Total capacity of projected plants ...	21,500	28,000
" " of plants in operation	11,500	14,500
Total capacity in 1898	33,000	42,500

	Tons.
Annual capacity in 1898 (in short tons)	7,650

When this production has been attained, it is quite probable that the selling price of aluminium will be as low as 1s. per lb., at which price there are, for practical purposes only, those cheaper metals, viz., iron, lead, and zinc.

III.—Electro-Thermal Processes.

We now come to the anti-climax—to processes which have, in Dr. Richards's opinion, outlived their usefulness. In these processes the current is converted as largely as possible into heat, and at the temperature obtained alumina is readily reduced by carbon. The Cowles Bros. used horizontal electrodes, and placed between them the mixture of alumina and carbon, using copper or iron to catch the aluminium and prevent its volatilisation. Pure aluminium cannot be made in this way, for there is large loss by volatilisation and oxidation, the quality of the metal is vitiated by absorbing carbon, nitrogen, and other elements present, and the metal is only obtained in the form of "shot," and by an interrupted, not a continuous process. Dr. Richards describes and illustrates the furnaces used at Lockport, N.Y. (U.S.A.), and at Milton, in this country; also the Héroult alloy furnace which was operated for several years in France and Switzerland, and experimentally at Boonton, N.J. (U.S.A.).

In summing up the points of interest presented by these electro-thermal processes, the author observes that so high a voltage is required to conduct these operations, and the aluminium obtained is so impure, that they cannot compete economically with the gentler, and yet much more efficient electrolytic processes, which are entirely displacing them. He is of opinion that the only possible way in which electro-thermal methods can be imagined to be successfully used is in the form of huge electrical furnaces, resembling blast furnaces, in which, with the use of suitable fluxes and reducing agents, and the intense heat obtained by the electric arc, raw bauxite would be reduced on a large scale to impure aluminium, which would then be refined by a chemical or electrolytic method.

THE VIBRATION OF ENGINE FOUNDATIONS.

By JAMES WHITCHER, A.Inst.E.E.

Vibration is a haunting spectre of engineers of central stations planted in crowded districts, and one immensely awkward to corner and lay. It is a presence from which such an one can seldom feel entirely free. In that very moment that he stands surveying with pride his row of engines, running so smoothly that to him their motion seems betrayed by scarce a tremor; even then there may be, in adjoining premises, some eager expert making seismographic tests, and securing tell-tale records of infinitesimal movements, which presently, in the imposing associations of the Law Courts, shall be magnified into a deadly, nerve-destroying influence, making intolerable burdens of his neighbours' lives, and calling for the instant suppression of him, his engines, and all his works. To be drawn by this uncomfortable spirit into the shoals of injunctions, made the bewildered sport of legal blast and counterblast, through which he must needs, in some desperate, brain-racking fashion, pilot his ship, or ignominously forsake it; this is the vision of fate that spoils his dreams.

The history of the Manchester Square station is well calculated to perpetuate such fears. This is the most notable case in point, for if ever adequate means had been taken to suppress vibration, it seemed at its inception they had been here. The foundations are described as consisting of a great block of concrete, 88 feet × 24 feet × 7 feet, weighing alone, say, 800 tons, resting in the excavation, free of the retaining walls, on a concrete floor or sub-base, with a layer of felt and lead intervening. The engines, driving direct coupled alternators, were Willans two-crank 200 I.H.P. The cranks being opposite, they are, to first appearances, in good balance, except for the endwise couple. Yet legal insistence, after the most exhaustive but unavailing efforts to confine the vibratory effects by yet further isolating the foundations, compelled the engineer to the drastic measure of removing the whole plant and replacing it by steam turbine alternators.

Messrs. Robinson & Sankey have shown that the effects observed were without doubt due, not to the unbalanced endwise couple, but to the irregularity introduced into the reciprocating motion by the finite length of connecting rod, which hitherto had been considered of negligible concern in engine balancing. Also, that in Willans three-crank engines, this influence is practically annulled. Hence, if there is any certainty in the surmise that the unbalanced couple is comparatively innocuous, the substitution of three for two crank engines would have proved a complete remedy of the evil.

Now, taking a broad view of the subject, the lesson of this and other instances seems to be that no amount of elaboration of the foundations affords a really effective safeguard against vibration, which is only to be found in a perfect balancing of the engine plant. Let us see how far this deduction is correct.

In the first place, to fix on a clear understanding of the cause and nature of the vibrations, imagine an instance. Suppose we have a single crank unbalanced engine of say, 10 inches stroke, with reciprocating parts weighing 500 lbs., while engine and foundation block together weigh 500 times as much. Then, if the whole be considered as floating entirely free in space, like Mahomet's coffin, the oscillations of the piston must, by the elementary laws of dynamics, produce a counter oscillation in the larger mass; the "stroke," or amplitude of which, will be $\frac{1}{500}$th of 10 inches, or ·02 inch. If the centre of gravity of the larger mass be not in the line of motion of the smaller, there will be a considerable tilting oscillation also, covering, in fact, an angle equal to that subtended at the C.G. of large mass by the stroke of the C.G. of the small mass; and the direction of the oscillations in space, will be changed into the line joining the C.G's. at the moment of starting from rest.

When the foundation block is firmly imbedded in the ground, its oscillations will be damped; but in what degree it is impossible to surmise. It becomes the source of vibration waves propagated through the earth around, in some respects as sound waves would be, and with the same velocity; but chiefly as surface waves. Wave motion implies a grow-

ing lag of phase of the oscillations of masses, as farther distant from the source. Wherefore, in a perfectly elastic medium it is a balanced motion, the sum of all the momenta being nil.

This important point means that although the aggregate mass in sensible motion in the waves may be enormous, the damping reaction on the source may be very small. In fact, these waves act to the source merely as a fly-wheel does to a revolving shaft. The source being central, the wave front in homogeneous soil is spherical, and as it widens out, the amplitude diminishes. In this way the vibratory movements may die away into insignificance before reaching forbidden ground; yet one must not build his hopes on this. For it is conjectural how small a vibration an acutely nervous and predisposed person can detect, though it is safe to say the limit is of well nigh incredible minuteness. Moreover, the nature of the subsoil may be variable, and cause the motion to be propagated mostly in one direction, in which abnormal vibratory effects would occur. And further, the conditions may tend to the formation of reflex waves, which, by interference with the originals, will intensify the motion in some spots, and annul it in others.

On the whole it is too speculative a proceeding to trust to these troubled agitations subsiding quietly in the bosom of mother earth. It is clear that, for a complete safeguard against vibration, it is essential either to reduce the oscillations of the foundation block to innocuous dimensions by some means in itself, or to completely isolate it from the surroundings. The former, in our simple instance, is to be done only by increasing the weight of the block relative to that of the reciprocating parts; but here the question arises, what is a suitable proportion? An extent of oscillation which proves harmless in one situation may be very harmful in another.

As to the possibility of isolation, we shall see that it depends upon the actual movements of the block. Let our simple engine be a horizontal one, mounted low on the foundation, and load this with weights above to bring the centre of gravity of the whole mass into line with the cylinder axis, thus eliminating the tilting action. Then the counter oscillations of the foundations will be horizontal and in line with those of the piston. Here perfect isolation is possible by mounting the block on rollers on a smooth floor, leaving it otherwise free. If all tendency to roll more freely in one direction than the other, and thus start the whole affair travelling, to the detriment of the steam connections, could be obviated, here is an ideal, if somewhat fantastic solution of the balancing difficulty.

Obviously, however, to small oscillations, a thick layer of non-binding sand or other material beneath the block would be a mechanical equivalent of the rollers. Whence arrives the important deduction that with horizontal engines, on heavily weighted foundations, there is little fear of vibration being transmitted to the surroundings, provided the sides of the block be free, and it be not bound to the ground beneath. The transmission of movements in this case depends solely upon the resistance to shear of the earth immediately supporting the block, which is trifling. Practical convenience is in the way of raising the centre of gravity of the mass of foundations and superincumbent plant so high as requisite, so that some tilting movement must remain; but we will refer to this later.

Now, if the engine be a vertical one, the block oscillations are vertical, and it is impossible to isolate them by any means short of suspending the whole to a balloon, and one might quibble against that. This second deduction establishes the importance of demanding a much nearer perfection of balance in vertical than in horizontal engines.

The above conclusions apply more or less generally, though deduced from consideration of a simple instance. In practice, the motions of the foundations must be more complicated, owing to the number of engines grouped upon them, and the variety of forms in which want of balance may be manifested in the several types of engines. It is convenient to enumerate the latter and describe their characteristics.

Almost all originate from the momentum of reciprocating parts; this original momentum being complicated by the influence of the connecting rod, it is well to resolve it into two simpler components, and discuss these separately. The primary component is the momentum the reciprocating mass would have if the connecting rod were of infinite length. The secondary component is the variation superposed upon the primary by the restricted length of the rod.

The following are some interesting facts concerning this secondary component; the calculations relating to a short form of rod, of length twice that of the stroke. Its periodicity is twice that of the primary component, the zero values occurring at angles 0°, 90°, 180°, and 270° of the crank, taken from the axial line, and the maximums near 45°, 135°, &c. The maximum value for the given length of rod correspond to ·127th part of that of the primary. In engines with two cylinders, side by side with equally weighted reciprocating parts, and cranks at right angles, the pair of secondary components nearly balance each other, combining into a resultant $\frac{1}{64}$th of the originals and half their period; *i.e.*, ·002 of the primary component, and four times the periodicity. In three cylinder engines, cranks 120° apart, this balance is yet more perfect, the unbalanced resultant being so small as ·0004 of the primary, and of $\frac{1}{8}$th its period.

(To be continued.)

ON ALTERNATING CURRENT-RUSHES IN CONDENSERS.

By BERNARD P. SCATTERGOOD, M.A., Oxon.

1. A short time ago, while making experiments on a high tension circuit, I noticed a phenomenon, the cause of which was not at the time apparent. I have used some of my spare time in an attempt to investigate the matter, and the present paper is the outcome of the attempt. I have called the phenomenon a "current-rush," because of a certain outward similarity which it has to the well-known transformer effect, although the cases are not altogether parallel. However, it is possible that a little side light may be thrown on "transformer rushes" by an investigation of the "condenser rushes" with which I have now to deal. The method, at any rate, of employing a spark-gap, by means of which the cycle of condenser current-rushes is repeated at every (normal) alternation, is one which I have employed with some success in the observation of current-rushes in transformers. I shall not, however, go into any detail on the latter head now, but shall confine myself to the effect as produced by the aid of condensers.

2. The phenomenon which I noticed was this. I had occasion to connect a condenser in series with a 16 candle-power 100 volt lamp across a pair of high tension (alternating) mains, at a pressure of 2,000 volts.

Under these conditions the current which passed through the lamp and condenser was about ·15 amperes, as estimated by the brightness of the lamp, which glowed faintly at something less than 30 volts. I found that when the circuit was broken, if the break were made very sharply and suddenly, the lamp went out at once; but if the action were prolonged, so as to allow a small arc to pass for an appreciable time between the wires as they were being separated, the current in the circuit seemed to increase considerably, and the lamp lit up to 80 or 90 volts, or sometimes even to a higher degree of incandescence. The frequency used on the occasion when the phenomenon was first observed was about 120 complete alternations per second.

3. It was found possible, by careful manipulation of the wire by means of which the circuit was made and broken, to maintain this state of things for some seconds; but as the intensity with which the lamp glowed varied considerably with very small alterations in the length of the arc, the condition was very unstable. I therefore inserted in the circuit a micrometer sparking-gap (P, in fig. 1), provided with a screw of small pitch, by means of which the arc could be accurately adjusted and maintained at exactly the same length. I now found that a continuous stream of sparks passed between the two electrodes, which emitted a humming noise, of the same pitch (as might have been expected), as the note of the alternator which was being used, showing that a spark passed at each reversal of the current. That this was the case was confirmed by the action of rapidly moving the eyes to and fro before the spark-gap, the effect of which was to draw out the spark into a chain of luminous

beads, separated by intervals of darkness. The equal spacing of these intervals showed that the spark occurred after equal intervals of time. When the micrometer was screwed up, so that the two electrodes were in contact, the lamp glowed at about 30 volts; on separating the electrodes to a certain point, the first effect was, that the lamp glowed less brightly; but as the length of the spark-gap was gradually increased, the current passing through the lamp, estimated by the intensity with which the filament glowed, increased correspondingly, the apparent pressure at the terminals attaining finally a maximum of considerably over 100 volts, judged by the eye; and the lamp remained glowing steadily at that apparent pressure, so long as the length of the gap was kept the same. On separating the electrodes still further, the sparks ceased to pass, and the lamp of course went out.

4. The condenser used in the first experiment consisted of 20 sheet iron plates, ·014 inch thick, and measuring 19 inches by 26, with mica as the dielectric. I used several condensers of different capacities during my experiments; but, as these were more of a qualitative than a quantitative nature, it may suffice to say that I obtained effects quite similar in kind, though differing in degree, with condensers of capacities varying from the two-hundredth to the fifth of a microfarad. The capacities were estimated by the current which the condensers would pass under a measured alternating pressure (of nearly sinoidal form) at a known frequency; as a check, a calculation was also made

Fig. 1.

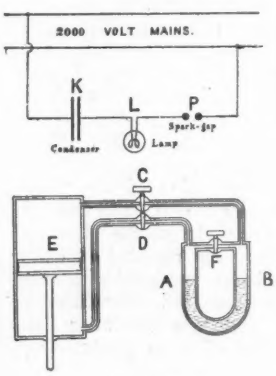


Fig. 2.

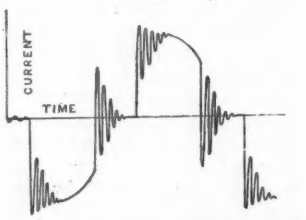


Fig. 3.

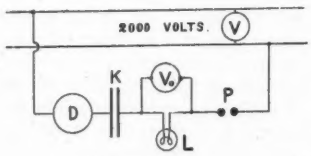


Fig. 4.

from the dimensions of the condensers and the S.I.C. of the dielectric used in each case, with fairly concordant results. The effect I have described was also shown very strikingly when one pole of a pair of high tension mains was connected through an incandescent lamp to one of the primary terminals of a large transformer, while the other pole was allowed to spark on to a secondary terminal, or to the iron core; the primary coils acting in this case as one coating of a condenser, and the core, or the secondary coils, as the other coating.

5. *Primâ facie*, it would be considered that the brilliancy with which the lamp glows is a measure of the current passing through the circuit; we have therefore, in the experiment of Sec. 2, to account for an increase of current through the condenser. Now the ordinary formula for the current through a condenser, due to an impressed alternating (sinoidal) electromotive force, of frequency n, is

$$\text{I} = 2\pi n \text{K E} \times 10^{-6}$$

the pressure, current, and capacity being expressed in volts, amperes, and microfarads respectively. If we assume that the capacity remains constant at all frequencies (this assumption involving the invariability of the specific inductive capacity of the dielectric which separates the plates of the condenser), then any variation in the current flowing in and out of the condenser can only be caused by a variation either in the impressed electromotive force, or in the frequency, or in both.

6. In order to see whether a rise of pressure sufficient to account for the increase of current does actually occur at the terminals of the condenser, when the electrodes of the spark-gap are separated so that sparking takes place, I put an electrostatic voltmeter across the condenser terminals; but on sparking, the indication of the instrument actually fell from 2,000 to 1,700 volts. (In this and succeeding experiments, unless otherwise stated, the frequency of the current used was 83 alternations per second, and the condenser had a capacity of about one-tenth of a microfarad.) Across the gap itself, the voltmeter also indicated a pressure of about 1,700 volts when sparks were passing; but on the mains, although the pressure rose slightly, the increase only amounted to something less than 1 per cent. While the above figures represent fairly the general result of the experiment, it should be said that there appeared to be one particular length of the spark-gap for which the pressure across the condenser *rose*, sometimes by as much as 10 per cent., from 2,000 to 2,200 volts. When this critical point was reached, either lengthening or shortening the gap had equally the effect of lowering the pressure at the condenser terminals. It would seem, then, that if the pressure at the condenser terminals *falls* while the current through it *increases*, the alternations of the current must necessarily be taking place at a higher speed than under normal conditions; and even allowing for a 10 per cent. *rise* of pressure, this is not, in itself, sufficient to explain an increase of current amounting to 200 to 300 per cent.

7. Recent research has made us familiar with the effects, long ago predicted by Maxwell, Lord Kelvin, and others, which attend, under certain conditions, the discharge of a condenser—the production, namely, of electrical surgings of very high frequency; and it has been shown experimentally that similar oscillations may also occur when a condenser is *charged*. (See a paper by Mr. Hay on "The Charging of a Condenser," in the *Electrician*, Vol. xxxv., p. 840.) The phenomenon before us appears to be of this class; and I shall describe experiments, the results of which tend to confirm the view that electrical oscillations of high frequency, whether or no they be responsible for the behaviour of the lamp in the experiment mentioned above, are at all events produced in a circuit such as that with which we are dealing, containing a condenser and a spark-gap.

8. What takes place, then, is probably something of this kind. Initially, the condenser is uncharged. When the pressure rises to a sufficiently large value, a spark strikes across the gap, charging up the condenser. The arc lasts until the pressure again falls to a value so low that it cannot bridge the gap, when the current ceases to pass, until the E.M.F. of the alternator again rises to such a value that the arc can re-establish itself. The cycle of phenomena is then repeated with reversed sign. Provided that a certain relation exists between the capacity, resistance, and self-induction in the circuit, the charging of the condenser, and probably, also, its discharge, is effected by a series of oscillations decreasing in geometrical progression, the frequency of the oscillations being*

$$\frac{1}{2\pi}\sqrt{\frac{1}{\text{L K}} - \frac{\text{R}^2}{4\,\text{L}^2}}$$

The necessary condition, just referred to, for the charging current to be oscillatory, is given by the formula†

$$\text{R}^2 < \frac{4\,\text{L}}{\text{K}}$$

In one particular set of experiments which I made, the quantities involved had approximately the following values:— R = 200 ohms (say, 20 ohms for the primary coils of the transformer which fed the high tension mains, and 180 ohms for the lamp) L = ·05 secohm, K = ·1 microfarad. It will be seen that the necessary conditions for oscillatory charge and discharge are here present; but calculation must always be difficult, owing to the uncertainty which exists as to the precise values of the resistance, self-induction and capacity of the spark-gap.

9. In the preceding formulæ, the assumption is, that the condenser is charged by means of a steady E.M.F. suddenly applied. In the present case, of course this is not so, as the E.M.F. of the alternator continues to rise after the charging current has established itself. While this complication will considerably affect the simplicity of the formulæ, the general results will remain as above, the effect of the

* Mascart and Joubert, Vol. i., p. 515.
† *Id.*, p. 513.

variation of the charging E.M.F. being simply to make the oscillatory current-curve unsymmetrical about the axis of time. Fig. 2 will give an idea of the current-curve during one complete cycle, that is to say, during the time occupied by one complete alternation of the impressed E.M.F.

10. A hydraulic analogy may serve to illustrate the manner in which these oscillations are produced. Imagine a U-tube, A, B (fig. 3), half filled with water. The limbs of the tube are connected at the top by means of pipes, C, D (which are provided with stop-cocks which can be opened and closed simultaneously), with the two ends of an air-tight cylinder, E, containing a piston, by the movement of which the air can be drawn out of A, and forced into B, or *vice versâ*. The limbs of the U-tube are also connected together—short-circuited, so to say—by a short tube with a stop-cock, F. In this hydraulic model the pump, E, is the equivalent of the dynamo in the electrical circuit shown in fig. 1; the sectional area of the limbs of the U-tube, A, B, represents the electrical capacity of the condenser, and any difference of level given to the liquid in A and B, represents a difference of potential to which the plates are charged; the total charge, therefore, positive or negative, is shown by the excess of the volume of liquid contained in A over that contained in B, or in B over that in A. Further, the self-induction of the electrical circuit is represented by the inertia of the liquid, and the electrical resistance by the frictional resistance to the passage of air in the pipes, C and D, which may be very great if the sectional area of the pipes is small, and the apertures of the stop cocks constricted, and small if the pipes are of large sectional area, and the stop-cocks wide open.

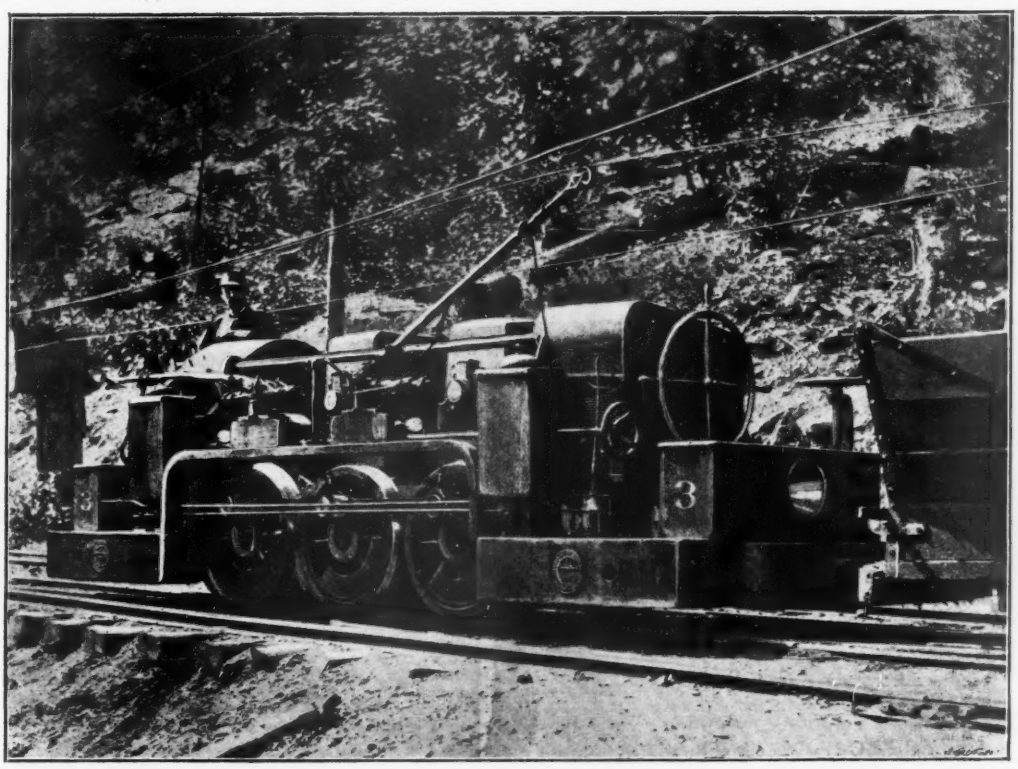
(*To be continued.*)

A NEW TYPE OF MINING LOCOMOTIVE.*

No recent announcement in the electrical field attracted more attention than that of the consummation of a working arrangement between the Baldwin Locomotive Works and the Westinghouse Electric Company. With the enormous field now open for electric traction, it was felt that the vast experience of the Baldwin Company in the field of steam locomotion would materially advance electric locomotive building, when combined with the successful and practical results of the Westinghouse Company in electric construction work. This combination is of interest to the mining interests of the country, inasmuch as it was at once announced that electric mining locomotives would be built.

The first of these machines ever turned out has recently been put in operation at the mines of the Crozer Coal and Coke Company at Elkhorn, W. Va., in the Pocahontas coal-field. The work to be done here is very heavy, inasmuch as there is a grade against the loaded trips, and a large tonnage per day is handled.

The illustration shows the locomotive just outside the bank mouth headed toward the tipple. The machine weighs 22 tons, making it the most powerful electric locomotive yet built for underground work. The total length is 17 feet 8 inches, and the width of this gauge of track (44 inches), is a little over 5 feet. The total height is 6 feet. The driving wheels, of which there are three pairs, with connecting rods



A New Type of Mining Locomotive.

on both sides, are 32 inches in diameter, and the distance between centres of axles is 3 feet, making the distance between centres of the outside axles 6 feet. The controller is on the end of the machine away from the trip, in the illustration, and the resistance coils are at the other end, with a ventilated covering. The resistance coils are iron strips one inch wide coiled like clock springs arranged in 16 rows.

The driving power is furnished by two series wound motors, with cross connected ring type armatures and two sets of brushes placed 90° from each other. The motors are rated at 100 H.P. each, and may be run in series or parallel. The series method is used for heavy loads at slow speed, and the multiple for higher speeds. The connection from the controller to the rheostat run under the motors in an iron casing, and the controller can be operated from either end of the locomotive. The switch to change the motor connections from series to parallel or back again is at the side of the controller switch, and can be thrown only when the controller is on the centre with all current cut out. No reversing switch is used, the reversal of direction being accomplished

* *Engineering and Mining Journal.*

by the controller, turning to the right starting forward and to the left backward.

The average speed of the machine under load, with the motors in parallel, is six to eight miles per hour, and the drawbar pull is sufficient to pull 40 loaded cars, each weighing 4 tons, up a 2 per cent. grade. Allowing 30 lbs. per ton for friction, &c., on a level track, and adding the load due to 2 per cent. grade, the pull developed must be over 11,000 lbs., which is very high for this weight of locomotive. The ratio between weight and drawbar pull for mining locomotives is usually 8 to 1 or 6 to 1, and the above figures show a ratio of 4 to 1, or even less, allowing that a portion of the power of locomotive becomes ineffective on the grade, being used in pulling the locomotive itself up the grade.

The exertion of 11,000 lbs. pull at a speed of 8 miles per hour means a consumption of about 235 H.P. At present, owing to insufficient generating capacity, trips of but 25 cars are pulled. The generating station was installed some time ago for the operation of a smaller locomotive and a number of coal cutters, and consists of an 18-inch × 20-inch McEwen automatic engine, belted to two 60 kw. Mather generators wound for 500 volts, so that running these in multiple gives but 120 kw., or approximately 160 H.P. for all purposes.

With 25 car trips, the locomotive takes 250 amperes in starting on a level, and 150 amperes as an average when under way on the level. As soon as sufficient generating power is obtained full trips of 40 cars each will be handled.

The connection between motor pinions and the driving axles is a double reduction train of gearing. Other points of interest about the locomotive are a switch for cutting off all current on the machines except for lights, two electric head lights, one at each end, each carrying a 32 C.P. lamp, two extra lamps on one side of the locomotive, as shown in the illustration, two trolley arms, one for locomotion in each direction, and but one used at a time; the gearing thoroughly encased, hand brake operating two brake shoes on each wheel, and a Wurts lightning arrester and choke coil.

The use of connecting rods is an interesting feature, and doubtless gives a more effective tractive effort than when each pair of wheels works independently. On the other hand, the pound on the track is greater, and on a rough mine track the loss by friction amounts to something. The operator has ample room at each end of the locomotive, and the frame forms heavy and substantial double buffers.

The Crozer mine is but a short distance from the Elkhorn Station, and anyone interested will be well repaid for the trouble of a visit to see this largest underground electric locomotive, and the success it is making in overcoming the difficulties of an exceedingly heavy service.

TRACTION DIAGRAMS.

By THOMAS TOMLINSON, B.E.

(*Continued from page* 40.)

We have then the materials for plotting the theoretical traction curve, giving p its value as deduced from the actual running; but we make no allowance for curves, we neglect air resistance as separate from frictional resistance, and we take no account of variations in drawbar pull, due to change of speed in the run, now increased as the car quickens its speed, now decreased as it slows.

As to curves, the experiments are so few, and the data so meagre, that the sensible plan will be to determine the effect by reading of actual traction diagrams.

The effect of curves on a line will, we know, depend upon three things:—

(1) The extra speed required over the rest of the line, to make time between the terminals, due to slowing at the curves.

(2) The energy required in overcoming friction and grade to carry the car round the curve at the reduced speed from the time of beginning, to slow down for the curve to full speed again after passing it, compared to the energy required for the same length on the straight at full speed.

(3) The energy required to accelerate the car to full speed after passing the curve.

We may get a fair idea as to the increase of p round curves by a few runs at a constant speed (as near as possible to the average speed round curves, as found in practice), for which speed we know accurately the torque corresponding to varying current; the motors should be in series, so as to ensure each doing the same work, and the current regulated by a dead resistance and a many pointed switch, so as to admit of small variations of current, and ensure nearly constant speed.

When we have the figure of increased p round curves, then from this and the length over which the slowing down for the curve, and the length over which the acceleration to full speed again takes place (which we shall find on our running diagrams), we can estimate the direct effect of curves, and, given the schedule time between points or average speed, we can also estimate the indirect effect due to increase in running speed.

As to the question of air resistance, as apart from frictional resistance, authorities are divided; the usual theory is a resistance depending upon area normal to direction of motion and square of speed. Comparatively recent experiments by Mr. Crosby, undertaken with a view to ascertaining its value for very great speeds, gave the law as depending upon the first power of the speed for speeds above 30 miles an hour (below which his experiments did not go), and from the plotted results it seems the law is true for the low speeds also.

The extra resistance will, for the ordinary speeds of tramway work, be small as compared to the other resistances, and may, without serious error, be taken as constant (the range of speed being small). It is to be noted that the value of p being obtained at high speed (and not by dynamometer pull at low speed) includes air resistance; but, using that figure afterwards to give drawbar pull, we multiply by weight of car and load in tons, and that part of the total resistance of which we find the value (and call it p), which is due to air resistance, does not vary with the weight of car and load. In fact, as before, in the case of the work done in the acceleration of the armatures, we include the effect, but we lump it up with p, which, properly, should be a measure of the resistance due to friction only, and we use this false p as though it were the true p, and all subject to the law of increase according to weight of car and load.

If we knew its real value, we should plot this value separately as drawbar pull to overcome air resistance, as a line drawn parallel to the base, and should deduct this value from p before multiplying it by the total weight to get total drawbar pull due to friction.

The only other element in the construction of our theoretical diagram of drawbar pull is that due to its increase or decrease above or below the value for steady running by the increasing or decreasing speed of the car, *i.e.*, the work absorbed or given out by acceleration or retardation of the car. Let v and v_1 be the velocities in feet per second at two points distant c and c_1 feet from zero of the base line, the curve of velocities showing constant acceleration (or retardation) between them. Then

$$\frac{2{,}240}{2\,g}\,(v_1^2 - v^2) = (c_1 - c)\,x,$$

where x represents the pull in pounds per ton necessary to give the acceleration or the equivalent of the retardation in lbs. per ton.

$$\left.\begin{array}{l}\text{Drawbar pull due to acceleration or}\\ \text{retardation in pounds per ton}\end{array}\right\} = \frac{2{,}240}{2\,g}\left(\frac{v_1^2 - v^2}{c_1 - c}\right).$$

The same formula gives us the drawbar pull allowance for starts, where $v = 0$.

We are now in position for a given line to plot the complete theoretical traction diagram of drawbar pull, and knowing the velocity at any point, can also construct the diagram of B.H.P., except round the curves, for which data are wanting. These data can be very quickly obtained by anyone who has the opportunity to get them.

Let us now consider an actual line, and see how the theoretical traction diagram works out. This is an actual section

of a line over which electric traction was proposed. I owe the section to the courtesy of Mr. Epstein. Let the figures for the line be :—

Distance in feet.	Length in feet.	Grade.	2,240 sin θ in lbs.
0			
280	280	1 in 50	+ 43
480	200	1 in 130	− 17·2
780	300	1 in 417	− 53·7
1,510	730	1 in 28·3	− 78·8
2,316	806	1 in 34·3	− 65·3
3,310	994	1 in 56·5	− 40·0
4,010	700	1 in 65	+ 34·4
4,728	718	1 in 485	+ 4·6
5,556	828	1 in 110	− 20·4
6,186	630	1 in 39·4	− 56·9
6,764	578	1 in 85	− 26·3
7,134	370	level	
7,364	230	1 in 64	− 35
8,190	826	1 in 295	− 7·6
8,775	585	1 in 172	− 13
8,933	158	1 in 144	− 15·5
9,087	154	1 in 70	− 32
9,441	354	1 in 59	− 38
9,603	162	1 in 73·2	− 30
9,763	160	1 in 123	− 18·2
10,660	897	1 in 390	− 5·7
10,885	225	1 in 140·6	+ 15·9
11,261	376	1 in 36·6	+ 61·2
11,327	66	1 in 28·7	+ 78
11,659	332	1 in 40	+ 51
11,767	108	1 in 108	+ 20·7
11,987	220	1 in 314	+ 7·1
12,152	165	level	0
12,432	280	1 in 560	− 4
12,738	306	1 in 146	+ 15·3
13,027	289	1 in 49	+ 45·7
13,227	200	1 in 27	+ 83
13,445	218	1 in 28	+ 80
13,830	385	1 in 57·5	− 38·9
14,040	210	1 in 27	− 83
14,208	168	1 in 24	− 93·3
14,450	242	1 in 25	− 89·6
14,705	255	1 in 53·3	− 42
15,171	466	1 in 53	− 42·2

The ruling grade of the line is not high, 1 in 136·7 (about ¾ per cent.); but the line crosses a valley with bad grades on each side. It is a fairly bad line to operate; the question is, How bad?

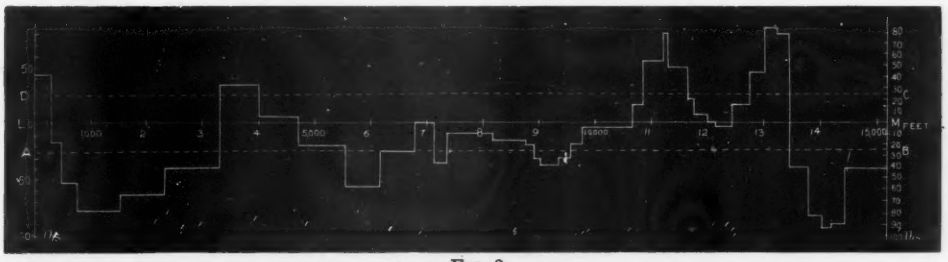


Fig. 2.

First plot the diagram for traction pull due to grade, in pounds per ton. This will be as shown in fig. 2, and is simply the graphic expression of the value of 2,240 sin θ: for a journey from left to right, all heights above the horizontal base line (which represents distances along the surface of the line) are positive, and below negative; on the return journey all below are positive, and all above negative.

(To be continued.)

CORRESPONDENCE.

Electrozone.

The British Electrozone Corporation can hardly afford to allow the communication published in your last issue to pass unnoticed.

Its product is there commented on, and, in all fairness, an equal publicity is requested for this reply.

In very brief terms, this Corporation is introducing to the attention of the European public a germicide and disinfectant which has been widely known and used in the United States for some years as "Electrozone."

The process for its manufacture has been operated successfully for a number of years, evidence of which will be found by reference to your own files (Electrical Review, August 25th, 1893, August 31st, 1894, and March 29th, 1895); to the Annual Report, Health Department, New York City, 1892); to the *Electrical Engineer* (New York), August 8th, 1894; to the *Engineering Magazine* (New York and London), October, 1895, and January, 1896; to the *Cosmopolitan Magazine*, January, 1896; and to many other publications, scientific and otherwise.

The presence of ozone is not hypothetical at all; on the contrary there is no ozone, nor has it ever been claimed that there is any ozone present in electrozone, but that ozone is produced by the action of electrozone on organic matter is the published opinion of the eminent authority, Mr. Edward W. Martin, chemist to the Health Department of the City of New York, as follows :—

"When the hypochlorites are brought in contact with organic matter—such as bacteria—chlorine is set free, which unites with the hydrogen of the organic matter thus destroying all germs contained therein. Ozone is formed together with nascent oxygen and peroxide of hydrogen, which oxidises and disintegrates the remaining portions of the organic material.

"In my opinion, the solution in question will prove an absolute disinfectant to organic matter, either of animal or vegetable origin."

For a number of years past the Electrozone Company of New York City, has been vigorously prosecuting its business.

Under the Board of Health of New York City, it disinfected Rikers Island in the Harbour of the City of New York, 30 acres of accumulated filth and garbage deposited by the Street Cleaning Department with such success that the *New York Herald*, in September, 1895, stated that enough vegetables had been grown on the now sterilised island—from the self sown seeds—to feed 17,000 of the pauper population. Under the same authority, it is treating, and has for some years been treating, a large portion of the water supply of the City of New York at Brewster's. The Board of Health, of Philadelphia, is also operating a plant (*vide* Officials Reports, for 1895, of Health Department, and Electrical Department).

Danbury, Connecticut, has treated its entire sewage for several years with this process. Many other public bodies also employ it.

In England, a demonstration plant at Maidenhead has been running for several months, and has produced results that have drawn warm praise from the most competent analysts and sanitary experts.

No plant has ever been erected and withdrawn after a few months for the want of efficiency or economy. In other directions equally satisfactory results have been secured with electrozone. Dr. Ogden Doremus; Dr. Cyrus Edson; Dr. Beebe; and a host of other reputable physicians, surgeons, and bacteriologists; the Bellevue Hospital; Willard Parker (isolating fever and diphtheria) Hospital; Laryngological Institute of New York; Post Graduate Hospital of New York; Cancer Hospital, Philadelphia; Wills Eye Hospital, Philadelphia; Cleveland Sociological Institute; the Hospital of Boston, Mass.; the Red Cross Society, whose Spanish representative, Dr. Abrisqueta certified to yellow fever cures in the hospitals in Havana; all the leading hotels of New York City; the Pasteur Institute of New York; large factories and public institutions; the Armouries of the States of New York and Massachusetts—all unite in declaring

electrozone to be a germicide and disinfectant of the highest efficiency, its value being increased by its non-poisonous quality and its cheapness of manufacture.

Whether any apothecary can prepare as active a hypochlorite solution cheaper than electrozone; whether the company referred to in your correspondent's letter can manufacture electrolytic hypochloride which annihilates disease germs and deodorises as well as electrozone; it is very evident that no corporation has hitherto ever offered to the public what is certainly, by the consensus of all scientific opinions in both England and the United States, a most powerful and valuable disinfectant and germicide, at once non-poisonous and cheap; and, what is equally significant, it is very doubtful whether any electrolytic hypochlorite solution was ever produced—save by the New York Electrozone Company, and this Corporation—which, five days or five years after its manufacture, was unabated in its germicidal quality.

Thanking you for this intrusion upon your columns.

The British Electrozone Corporation, Limited.

In the electrolysis of sea water, hypochlorites of sodium, &c., are formed, but no ozone is present in such compounds. Electrozone is a fancy name which makes those who do not know believe that there is ozone in it.

Assuming that in the electrolysis of sea water, ozone is formed, ozone, which is a most unstable substance, would be decomposed at once and return to its primitive state of oxygen. Therefore in bottled electrozone there is not a trace of ozone.

If there is no ozone in electrozone, is it fair to trade under the colours and the good name of ozone?

E. Andreoli.

[Our correspondent will notice that the British Electrozone Corporation disclaim that their solutions contain ozone. This, if produced at all, seems to result from the application of the electrozone.—EDS. ELEC. REV.]

Travelling Cranes.

With reference to your remarks on cranes in your issue of 10th inst., page 32, we notice you state as an advantage of the *one motor crane* its "rapidity in starting" owing to the fly-wheel action of the mechanism already in motion. Now this we wish to point out as one of the *disadvantages of this type of crane*, as it causes the load to swing if the crane is geared to travel at a fairly high rate of speed.

This has been brought very clearly to our notice in our own works when comparing the speeds we are now travelling our three-motor cranes with what we used to run our rope driven cranes at. A year or two ago we slightly increased the speed of one of the latter (rope-driven cranes), and our workmen considered the speed dangerous, owing to the sudden starting swinging the load as mentioned above. We have since entirely replaced the rope cranes with three-motor electric cranes, and are running them at speeds varying from two-and-a-half to three times that of our old cranes, and our men find no inconvenience or danger. We quite agree with your remarks as to the convenience of control from the floor, four out of our five cranes being controlled in this manner.

Joseph Adamson & Co.

"Efficiency of Transformers."

In the ELECTRICAL REVIEW of July 10th, Mr. Still asks my forgiveness for pointing out the error of my ways of reasoning; when he shall have done so, this will be readily accorded and my best thanks added.

The author of the letter under the above heading tell us that:—

> Had he not, however, taken it for granted that the secondary of a transformer has self-induction . . . . . he would have seen that his formula instead of being merely an empirical one, is really in such perfect agreement with our present theoretical knowledge as to warrant its being adopted as one of the most exact methods, &c., &c.

I do not know in what part of my paper I take it "for granted that the secondary of a transformer has self-induction"—though it ought to be a matter of common knowledge that the secondary coils of some transformers *have* self-induction—nor did I ever consider the formula I gave "merely an empirical one," but stated that it gave "the practical efficiency," not in all cases the absolute efficiency.

The next paragraph—

> In the column and a half following, ... and says so much that is either obscure or inaccurate, and so little that can be readily assimilated by the lay mind, that it is difficult to see exactly where he begins to go wrong—

is a very pretty one, but the printers have carefully omitted every part of that "column and a half" in all the copies of the E. R. that I have yet seen; however, I fully appreciate and endorse the meaning conveyed by the last 12 words of the paragraph just quoted, with the "*is*" emphasised.

I was previously ignorant of the fact that the paragraph—"Leakage it will be seen, &c., &c."—quoted from my paper, was a summation of the preceding series of statements contained therein, though it should be stated that

V = total secondary voltage drop.
A = secondary amperes.
α = difference in phase between the amperes, A, and volts, V.

"The truly wonderful" will be easily understood from a perusal of the *actual* sentence and *the quoted interpretation thereof:*—

Actual sentence:—

> In order to demonstrate that there *may* be a voltage drop due to magnetic leakage which does not necessarily represent expended energy.

Quoted interpretation:—

> that the drop in the secondary coil due to leakage of magnetism does *not* represent loss of energy.

I agree with Mr. Still's remark at the very commencement of the next paragraph with reference to the preceding part of his letter, but have not yet severed the connection between my theory and the results of my experiments.

I am only able to claim eight years incessant use of diagrams, but "*could* always represent," &c., &c., and *would* ask of what dimensions "so far" is, it being directly opposed to my wish or intention to "consider geometrical proofs of problems to be so far beneath the notice of a mind imbued with theory."

In the paragraph

> "Without denying that," &c., &c.

we have an admitted *self*-induction in the secondary circuit if the transformer is *specially badly designed*.

I have designed transformers purposely having a large self-induction in the secondary coils, but because it was intentional I do not think it fair to consider the transformers *badly designed*, for they were fitly designed for their purpose.

In the last part of this paragraph we have an admitted secondary coil's *own* magnetism, and yet we are told that it is impossible to conceive such magnetism to be *created* by the (current traversing) the secondary coil.

Next we are introduced to a "primary core" and a "secondary core," together with more statements, which produce a *result*.

Mr. Still has evidently forgotten that I was dealing with "The single-phase alternate current transformer in *practice*," and also that the variation of flux in air does not cause any hysteresis or eddy currents; when he shall have considered these two points he will read his own letter with as much surprise as I, and doubtless many others, have done.

It is obvious that Mr. Still's methods of reasoning differ from mine, though it gives me pleasure to think he has deduced a something from my results which suits his ideas.

A. F. Berry.

July 10th, 1896.

Electric Lighting, &c., in Spain.

It has afforded me considerable gratification to observe the efforts you are making to induce British manufacturers to contend, more particularly, for the acquisition of Spanish and South American electric lighting contracts; and your apposite observation that that which can pay a German, Austrian, or French firm, should surely pay an English one, deserves careful consideration at the hands of British contractors. It must be obvious to your readers, from the weekly information you place before them, that the question of electric lighting and transmission of power is becoming

almost a more universal matter with Ibero-American countries than with any other nationalities throughout the world; and surely the risks there are to be run (fiscally speaking), can be borne equally as well by British manufacturers as by Continental companies.

I have recently been addressed by the Consulate of the United States of Mexico, with particulars and plans of the tender for the lighting of the City of Mexico; and this contract is one that should strongly commend itself to manufacturers and contractors on this side, inasmuch as there can be no question as to the financial strength of Mexico, nor as to the city's ability to meet any and all of its engagements.

I shall be very pleased to afford any information needed to your readers with regard to this contract, on their placing themselves in direct communication with me.

The Editor El Ingeniero.

50, Fenchurch Street, E.C.

LEGAL.

Dr. Hopkinson's Three-Wire Patent.

The Judicial Committee of the Privy Council at Whitehall, on Wednesday, had before them the joint petition of Dr. Hopkinson and the Westinghouse Electric Company for a prolongation of Dr. Hopkinson's three-wire patent. The Committee consisted of Lords Hobhouse, Davey and Morris, and Sir Richard Couch. The petitioners were represented by Mr. Fletcher Moulton, Q.C., Mr. R. Wallace, Q.C., and Mr. R. Walter; while the Crown was represented by Sir Richard Webster, Attorney General, and Mr. Sutton. Mr. W. Neill appeared to oppose on behalf of the Whitehaven Corporation; Mr. Bousfield, Q.C., and Mr. Jenkins, Q C, for the Corporations of Glasgow, Dundee, Hull, and Bradford, and the National Electric Supply Company of Preston; Mr. Ashton for the Callender Bitumen Company; and Mr. Cripps, Q.C., and Mr. J. C. Graham, for the Corporations of Edinburgh, Aberdeen and Belfast.

The Attorney-General took a preliminary objection to the petition, on the ground that Dr. Hopkinson had sold his patent outright to the Westinghouse Electric Company for the sum of £19,400, and therefore, he said, it could not be contended on the face of the petition that it was for the benefit of Dr. Hopkinson. He submitted that by assigning his patent, Dr. Hopkinson had derived all the benefit he ought to obtain from it, and he contended that there were no grounds upon which the committee could grant an extension of time to the assignee. He quoted the case of Bowerdorf, which occurred in 1885, in which it was clearly laid down that an assignee of a patent could not be granted an extension of time; such a prolongation could only be allowed to the inventor.

Mr. Bousfield submitted the same point on behalf of the other opposing parties.

Mr. Fletcher Moulton argued that it was in the public interests that an inventor should assign his patent to some individual or company who would find the necessary capital to work it, and he should submit that in a case like the present, where the assignees had treated the patentee liberally, they had placed themselves in the position of the patentee. The invention was undoubtedly one of great merit; but for the first six years of its life it was prevented from having any commercial value, because of legislative difficulties, so that practically the patent had only had about eight years' commercial existence. The assignees took the patent after those six years, and really stepped into the patentees position, and now at the end of the term they came and asked their lordships for a prolongation of it. He took it that the power of the Privy Council in that respect had always been used for the reward of meritorious inventions, and Dr. Hopkinson's patent was undoubtedly one of great merit. At the present day it was almost universal for patents to be sold to, and worked by, joint stock companies, and Dr. Hopkinson's patent had undoubtedly been the means of saving half a million of money to the public. On those grounds he asked their lordships to hear the case, and not to sustain the objection which Sir Richard Webster had taken.

The Attorney-General replied that his contention was that on the allegations in their own petition, the petitioners must be nonsuited, because they asked the Privy Council to go directly in the teeth of the Act of Parliament.

After deliberating for some time in private, Lord Hobhouse delivered judgment. He said: Their Lordships are of opinion that the objection raised by the Attorney-General arising on the face of the petition must prevail, and therefore their Lordships cannot report to Her Majesty in the way which is necessary for the prolongation of the patent. They will not now deliver their reasons, being desirous to look further into the cases, but will deliver them at some future date. The petition was therefore dismissed with one set of costs.

Lighting a Club.

In the Westminster County Court, on Monday, his Honour, Judge Lumley Smith, Q.C., tried the case of Lee *v.* Piper, which was a claim by Messrs. Lee & Hancock, electricians, of 111, Sydney Street, Chelsea, S.W., to recover the sum of £23 17s. 11d., for work done.

Mr. Lee deposed to doing the work at the New Wheel Club, Kensington. It consisted of lamps, brackets, wires, &c. Cross-examined: Defendant was a decorator, and did not supply electrical fittings himself. He received orders from Mr. Oliver, secretary of the club. Gave an estimate for £9 to defendant for electrical fittings in the conservatory, for which he was paid. The order for four lamps and brackets he got from Mr. Oliver. Understood from defendant he was to do what Mr. Oliver ordered.

Mr. Oliver said defendant had a contract with Mr. De Pinna, the club proprietor, for £771. He arranged with defendant that his order to plaintiff for lights and fittings should be put on his bill. Cross-examined: Arranged with defendant that he could order anything. Piper had been paid for the work.

Mr. A. Piper, the defendant, said plaintiff estimated for £9, and was paid. He only charged that amount to Mr. De Pinna. Did not give Mr. Oliver permission to order electrical fittings, as he had stated. He agreed, however, to include them in his account.

His Honour found for the plaintiff, with costs.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending July 14th, 1895.	£	s.
Amsterdam. Teleph. mtl.	100	0
Auckland	55	0
Bergen. Teleg. cable ...	3,300	0
Bombay...	112	0
Brisbane. Teleg. mtl. ...	45	0
Brussels...	413	0
Buenos Ayres	449	0
„ „ Teleg. mtl.	2,271	0
Calcutta	162	0
Cape Town	80	0
Delagoa Bay	21	0
East London	328	0
Flushing	35	0
Halifax. Teleg. cable ...	5,300	0
Launceston	30	0
Odessa. Teleg. mtl. ...	55	0
Sydney	10	0
St. Petersburg	60	0
Wellington	25	0
Yokohama	39	0
Total	£12,920	0

Week Ending July 14th, 1896.	£	s.
Adelaide	25	0
Alexandria	22	0
Amsterdam	150	0
Baltimore	18	0
Bilbao	56	0
Boulogne	18	0
Buenos Ayres	830	0
Cadiz. Submarine cable	7,300	0
Callas. Teleg. mtl. ...	22	0
Calcutta	13	0
„ Teleg. wire	69	0
Cape Town	420	0
Colombo...	200	0
Durban	48	0
East London	367	0
Gijon	8	0
Hong Kong	86	0
Melbourne	360	0
„ Teleg. mtl.	242	0
Novorosoisk	1,200	0
Odessa	200	0
Port Elizabeth	147	0
„ „ Teleg. mtl.	775	0
Rangoon	84	0
St. Petersburg	40	0
Santos	77	0
Singapore. Teleg. mtl.	2,610	0
Stockholm. Teleg. mtl.	655	0
Suez	10	0
Sydney	343	0
Vera Cruz	110	0
Wellington	489	0
Total	£16,994	0

Foreign Goods Transhipped.

	£	s.
Trinidad. Teleph. mtl.	95	0

Dissolutions of Partnerships.—Mr. Wm. H. Druce informs us that the partnership existing between Mr. Bennett and himself, under the style of Bennett & Druce, was dissolved on June 26th. Mr. Druce has taken offices at Temple Chambers, 33, Brazenose Street, Manchester, and will in future devote himself exclusively to the practice of consulting engineering.

Messrs. W. Fox and T. E. Rowe, carrying on business as electrical engineers at 64, Fountain Street, Manchester, under the style of Wm. Fox & Co., have dissolved partnership. Debts will be attended to by Wm. Fox.

Liquidation Notice.—The Improved Electric Glow Lamp Syndicate, Limited, is to wind up voluntarily, Mr. S. A. Bartlett, of 1, Arundel Street, Strand, being appointed liquidator. This was resolved at meetings held on June 19th and July 6th.

Exhibition Lighting.—Messrs. Conze & Simon inform us that they are supplying the incandescent lamps for the Earl's Court and Cardiff Exhibitions.

Outing.—The employees in Messrs. Easton, Anderson and Goolden's electrical department held their first annual outing on Saturday last at Margate.

Paul v. Wonderland, Limited.—At the Clerkenwell County Court, on 14th inst., before Judge Meadows-White, R. W. Paul, of 44, Hatton Garden, sought to recover from "Wonderland, Limited," a music hall company conducting their business in Whitechapel Road, £22 10s., three weeks' rent of electric accumulators supplied to the defendants on hire. The defendants counter-claimed for £15 damages. The Judge gave judgment for the plaintiff with costs and disallowed the counter-claim.

Price Lists.—The Carbon Syndicate, Limited, have issued lists of the "Irex" carbon, of which they are the sole manufacturers. Dimensions and prices of pure carbon crucibles, pure carbon plates for Leclanché batteries, and also for batteries and electrolysis are given. The advantages claimed for the "Irex" carbon, and a list of the various agents are also included.

Tesla Transformers for Röntgen Photography.—Fig. 1 shows a complete Tesla apparatus, being patented by Mr. L. Miller, for obtaining high tension oscillating discharges from the street electric light mains, where the current is alternating. The illustration is taken from a set of apparatus supplied to St. Bartholomew's Hospital for obtaining photographs of injured limbs, &c., by means of Röntgen rays. Messrs. Miller & Woods supply a standard

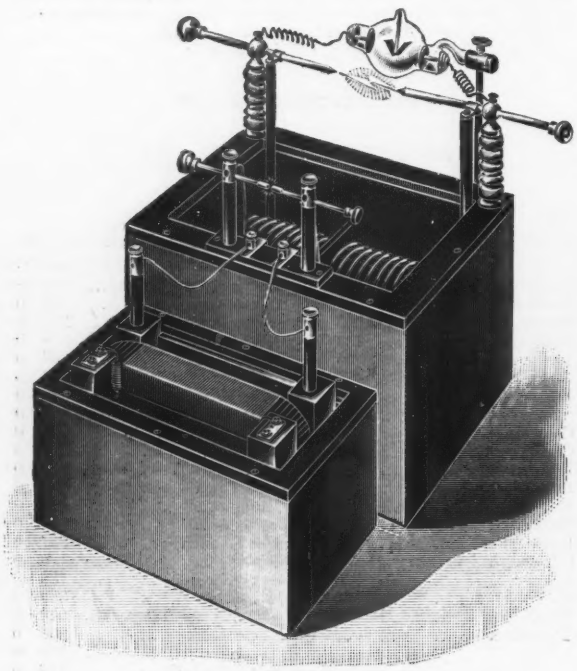


Fig. 1.

set which gives a stream of sparks over more than a 6-inch air gap. The set consists of a step up transformer (fig. 1) from 100 volts to about 6,000 volts, and taking the same current as two lamps of 16 candle-power each; a condenser; and a Tesla transformer to about 70,000 volts. The condenser discharges by rapid oscillations of current across the spark gap (shown in figure) through the primary thick wire winding of the Tesla coil. Induced currents are then set up in the inner thin wire secondary winding of the Tesla coil.

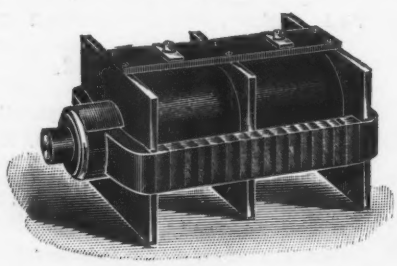


Fig. 2.

These are led to the discharge rods and can be used to excite Röntgen rays in a single or double focus tube as shown, or demonstrate the Tesla experiments. The boxes in which the above are contained are filled with mineral oil. Fig. 2 shows a high tension transformer which can be used up to about 4,000 volts without oil. It is said to be a neat compact form of transformer for exciting vacuum tubes, ozone generators, &c., and can readily be connected to the electric mains by means of a lampholder attached to a piece of flexible cord.

Torpedo Boat Destroyers.—H.M.S. *Swordfish*, one of the torpedo boat destroyers built by the Elswick firm and engined by G. E. Ballis & Co. (Limited), which recently made a record passage, on Tuesday passed, with equal success, her dockyard official full power trial at Chatham, the average power developed by the machinery being 4,359 I.H.P., or about 10 per cent. above the contract. When it is borne in mind that the total weight of the engines and boilers only amount to 56 lbs. per indicated horse-power against 400 lbs. in the fastest Atlantic liners, the care required in designing and working with such reduced factors of safety as is necessary in these vessels will be better appreciated. The full run was made from the Maplin Sands toward Harwich and back, and concluded with circle turning at full and half power ahead and astern and throughout the whole of the trial there was not the slightest hitch of any sort with the machinery and boilers.

To Creditors.—The *London Gazette* contains a notice requesting creditors of Swinburne & Co., Limited, to send their names and addresses and particulars of their debts, &c., to Mr. H. E. Sherwin Holt, of 66, Victoria Street, S.W., the liquidator, on or before August 31st.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The electrical engineer has applied for an increased salary.

Asylum Lighting.—With reference to our Note regarding the proposal to light the Bath and Somerset Asylum, we understand that the Committee asked seven firms to submit schemes and tenders for the complete work—engines, boilers, &c., for lighting this asylum. These firms sent in the various reports, &c., and the whole were submitted to an expert. After considerable discussion with the Committee, the scheme of Mr. T. Scott Anderson was selected. The scheme was then ratified with one or two unimportant modifications, and the contractor is now commencing the work. The dynamos will be to the Admiralty specification at a pressure of 205 volts; two complete generating plants are to be erected, and also, as a safeguard, a large battery of D.P. cells, equal to one complete generating plant for five hours. The contractor's chief engineer (Mr. Saycatch) has proceeded to Somerset to superintend the erection of the plant.

Ballymena.—The Town Commissioners intend applying for a provisional order for electric lighting.

Bangor.—Mr. F. J. Warden-Stephens, of London, has offered to submit report and tabulated statement in the matter of lighting the town with electricity, for a fee of £20. The question of electric lighting having been dropped consequent upon the gas extension scheme, the letter was marked read.

Redditch.—The Manchester Edison-Swan Company want to apply for a provisional order for lighting this district, but the District Council seems to think that if the work is to be done, the Council should do it. The matter is to be further considered.

Bermondsey.—The Vestry is to oppose the application of the County of London and Brush Provincial Company for a provisional order.

Blackwall Tunnel.—At the London County Council meeting on Tuesday, the Bridges Committee reported as follows:—"We have to report that for some months past we have been considering the question of lighting the Blackwall Tunnel, and that we have come to the decision, after inspecting the tunnel, that electricity is the best and cheapest form of lighting. The continuous requisition of the light both day and night will require a uniform supply which will greatly decrease the cost per unit. The cost will reach £25,000, which includes buildings, subway, plant, mains, and lamps for the light at 10 feet centres, and will be paid out of the £50,000 provision money which has been set apart for work of this description. We have given directions for the buildings for the generation of the electricity to be erected on Northumberland Wharf, Poplar, as it is the most convenient site for the purpose, and have agreed to use No. 2 shaft on the wharf for tunnel purposes only. With regard to the prices for the buildings, we have arranged with Messrs. Pearson and Son, the contractors, such terms as we think are favourable to the Council. With regard to the plant and machinery, the specification is well in hand, and the necessary drawings are being prepared, and we anticipate that the working of the installation, exclusive of depreciation, repairs, and capital charges, but including lamp renewals, will be about £5,000 a year. We have arranged for three lines of lights in the tunnel, and each line to be controlled independently at the engine-room switchboard. The surface and sunk approaches will have a line of lights on each side as in ordinary street lighting; this will reduce the attendance for lighting and extinguishing the lamps to a minimum. With regard to obtaining the plant, we are of opinion that the best course to take is to obtain tenders from a few selected firms, as it is necessary that the plant to be supplied should be of the highest excellence. As the Council is about to adjourn for the summer vacation, and as the work must be proceeded with without delay, we recommend that the Bridge Committee be authorised to invite and accept tenders for the plant required in connection with the lighting of the Blackwell Tunnel, and that the operation of standing order No. 178 be suspended accordingly."

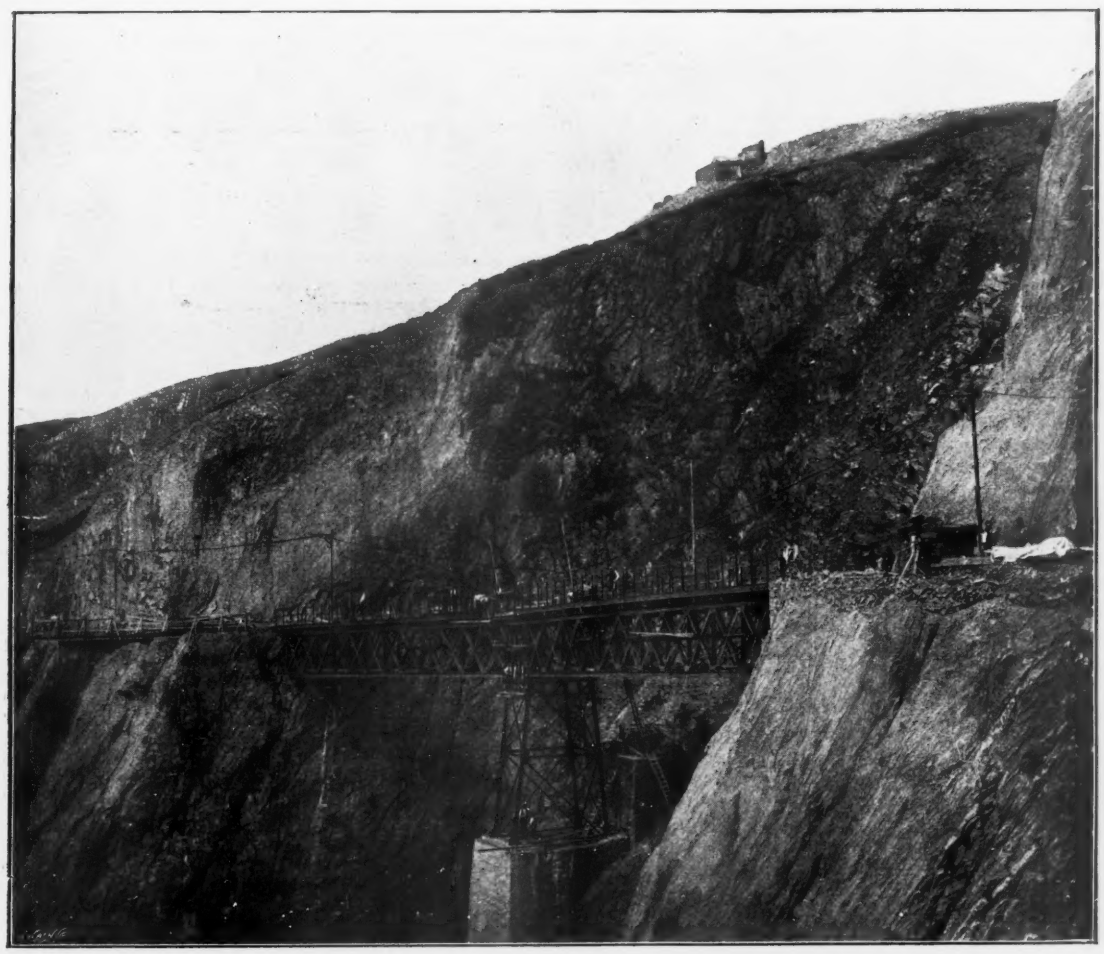
Boston.—The Paving and Lighting Committee has been directed to inquire into the advisability of erecting an electric light installation for lighting the town and dock.

Bradford.—J. P. Rushworth & Co. have just completed an installation of the electric light at the West Bowling Co-operative Stores, Bowling Old Lane, Bradford. The installation comprises a gas engine, a Silvertown dynamo, and about 280 16-C.P. lamps. The same firm has just also entered into a contract with the Great Horton Co-operative Society for an installation of about 250 lights. A Silvertown dynamo has also been chosen in this instance.

(*Continued on page* 81.)

A NEW ELECTRIC RAILWAY IN THE ISLE OF MAN.

For the past four years the summer season in the Isle of Man has been marked by the opening of an electric tramline. Whether a similar event is to signalise the advent of each season is a little difficult to say; but there is little doubt that Manxland will very soon be the most tramwayed country in Europe. There are now three distinct electric tramlines—the Douglas and Laxey, the Snaefell Mountain Railway, and the Port Soderick. This, however, does not close the history of the Manx tramways, for a scheme to connect Douglas and Ramsay by an electric line is projected, and



A View of One of the Bridges on the Douglas Southern Tramways.

likely enough will be carried out. The phenomenal success that has attended the Douglas and Laxey electric tramway has probably been responsible for the developments in tramway work that have occurred in the Isle of Man.

The new line, which has just been completed, extends from Douglas Head to within a short distance of Port Soderick. It passes over what is known as the Marine Drive, a road which was built through the cliffs some few years ago by joint stock enterprise. The scenery traversed by the line has many of the special characteristics of Manxland. Between Douglas and Port Soderick there are none of the famous glens, but there is a grandeur about the cliffs which imposes silence upon the beholder, therefore we will not say much about them. The localities through which the line passes bear names that astonish a stranger. There is Coolebegad, Purt-my-Coan, Little Ness and Rebog, The Whing, Slack Indigo, and Horse Leap. We are told that the inhabitants of mountainous regions are romantic, and it is not surprising that many a romance is weaved round the Manx districts. The origin of Horse Leap is a melancholy one, if we accept the story, and it is certainly romantic enough to accept. A party, while hunting in the neighbourhood, came to Horse Leap, a ravine some 50 feet in width, and 150 in depth. A lady, more venturesome or more careless than the rest, approached too near the edge of the cliff, and a fatal slip sent horse and rider hurling to the bottom. To say more, however, might lead our readers to institute unfavourable comparisons between our method of telling Manx stories and those of Mr. Hall Caine, therefore we will turn to the more prosaic details of the tramway.

Actual work on the track was commenced on December 30th of last year, after the necessary surveying had been done by Mr. Lavington Fletcher, of the New General Traction Company. As we have already said, the line is under three miles in length, but, speaking frankly, we never walked a harder three miles. One of the most interesting features of the line is the bridges. These have been built by Messrs. Heenan & Froude, of Manchester; they are of the steel girder type, and have replaced the old wooden bridges that formerly existed. The first one is about half a mile from the gates of the Drive, and close by the power-house. It spans what is known as the Pigeon Stream, and has a total length of 117 feet. This bridge is built in three spans with steel piers. The second bridge, about three-quarters of a mile from the power-house, is known as Port Wallberry. The total length of this bridge on the centre line is 230 feet. It

is built in two spans of 110 feet each. It may be mentioned that this bridge is about 200 feet above the sea.

The most remarkable feature about the line is the tremendous amount of curvature, there being hardly a straight length anywhere. Naturally such conditions have greatly added to the difficulties in constructing the overhead wires. The shortest radius is 45 feet on the centre line. The gradients are considerable, the steepest one being about 1 in 16. The track from the power-house is a continual rise to the end of the line, there being one mile of continuous hill. Vignoles steel rails are employed, which weigh 65 lbs. to the yard. They are bonded together by single bonds of the "Chicago" type, and are cross-bonded twenty times in a mile; in addition, they are cross-bonded at all the turn-outs. The rails are laid on steel sleepers, which by the way are ready gauged. The turn-outs are arranged for a five minutes' service, there being 7 turn-outs in the $2\frac{1}{2}$ miles. In very many cases it has been found necessary to widen or alter the existing roadway in order to ease the curves or provide sufficient room for the turn-outs. This has proved by no means an easy task, for it has often meant the removal of portions of heavy cliffs.

The poles which carry the overhead wire are of hollow steel, and carry single arm brackets; they are built in three sections, and are manufactured by Messrs. Morris & Tasker, of Philadelphia. Owing to the exceptional curvature in the line, there is considerable variation in the length of the arms that carry the overhead wires; but the special form of trolley employed, devised by Mr. R. Blackwell and Mr. Philip Dawson, allows of considerable latitude in this direction. The trolley wire is double throughout, as at Coventry, and is of No. 20 gauge; like most of the other material, it has been imported from the United States. The height of the trolley wire above the level of the ground is 20 feet. The line is divided into half-mile sections, the junction boxes being fixed on the poles. The feeders are carried on the poles; one starts from the power-house, and extends as far as the Whing, a distance of $1\frac{3}{4}$ miles. The line material, such as sectional insulators, &c., does not differ from what is employed at Coventry, which was fully described in our article on that system. Throughout the system the track is laid on the land side of the road, and at no point does it approach the edge of the cliffs. The car shed is at Little Ness, about two miles up the line from Douglas. It is a light iron building, 93 feet in length, and 40 feet wide, and will accommodate about 12 cars. Down one side is a pit extending over half the floor, which provides ample space for inspecting the motors and the underneath portions of the cars, and at one side of the shed is a workshop 16 feet square, the floor of which is on a level with the pit. There have been great difficulties in securing flat pieces of ground suitable for car sheds and power-house, and it is surprising, therefore, to find the car shed some 8 feet below the level of the track. A single line leads from the road to the car shed, there being a traversing table at the door.

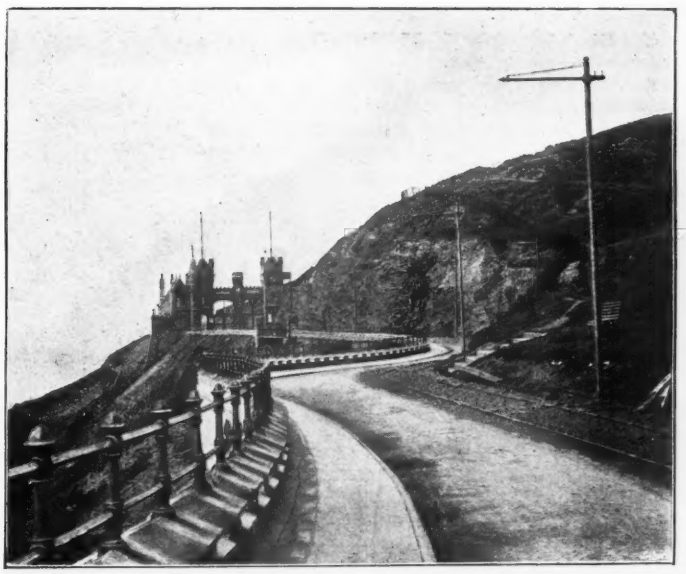
A View Along the Line.

At the present moment there are 12 cars, six motor cars, and six trailers. The bodies were built by the Brush Electrical Engineering Company, and are excellent specimens of the open car. They are two-storey cars, and have seating accommodation for 78 psssengers. They are 28 feet long and 7 feet wide. Although there are outside seats, it would be impossible for a tall man to touch the trolley wire with a stick or umbrella. The trucks of the cars are of the Lord type, and are made by the Baltimore Car Wheel Company; they have wheel centres of 6 feet 6 inches, and are provided with truss roads which are carried underneath the platform at each end of the car. The cars are provided with blinds, which can be strapped down in rainy weather. To prevent passengers getting out of the cars when running, a narrow movable board is provided on the sides of the car.

There are on each car two motors, which are controlled on the series parallel method. The motors are of the Westinghouse standard A, railway type, and are rated at 30 H.P.

They are in waterproof cases, and are readily accessible from the floor of the cars. The side-bar method of suspension is used on the motor cars. Single reduction gearing, which runs continuously in an oil bath, is employed.

At each end of the car is a Westinghouse 28A series parallel controller; this, it may be mentioned, is the latest and improved type. There is a considerable difference between this and the one in use at Coventry. There are seven notches instead of six. The first four notches are series, and the last three put the motors in parallel. There is also on the controller a reversing switch, which has three positions; it is moved backwards or forwards to make the car go in that direction. When the reversing switch is on the centre, the controlling handle is locked; when the reversing handle is in a backward or forward position, the controller handle is free, and directly the controller handle makes contact and allows the current to pass, the reversing handle is locked, so that it is impossible to reverse with the current on. It is also impossible to cut off current with the reversing handle when the controller is round. There are also two plugs on the controller, the function of which is to cut out each motor. In the case of a motor being cut out, there is no object in going beyond the fourth notch on the controller, so there is a locking device which comes into operation and prevents the handle going beyond the fourth notch. The cars are provided with foot gongs, and it is interesting to mention that the operation of striking the gong also works a ratchet wheel which turns round the gong, the object being to prevent hammering on the same spot, and thus avoid cracking the gong. There is the usual switch at each end of the car for cutting off, in the event of anything going wrong with the controller. If in running down hill the brake did not pull up the car, there would be two ways of stopping; one would be to reverse the car by simply shifting over the reversing lever and turning on the current gently to the first or second notch; that would bring up the car very shortly. A second method of stopping the car which could be adopted when the trolley jumped the overhead wire would be to open the canopy switch, reverse the car, and put the controller handle right round to the end, and the motors would then run as dynamos, and serve the purpose of brakes. There is a lightning arrester and the usual resistances on each car. Incandescent lamps are provided on the cars, inside and out, the necessary electric energy being obtained from the trolley wires.



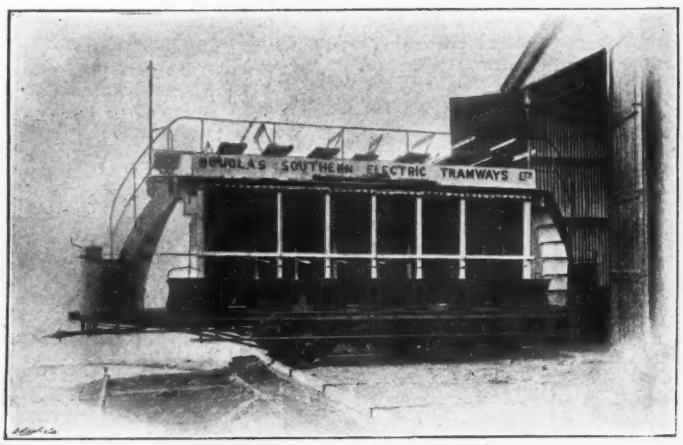
The Entrance to the Marine Drive.

The power-house is of a most peculiar character. Owing to the difficulties in getting sufficient ground, the building is a two-storey one; even then it was found necessary to cut a hole in the rock for the lower room. The engine room is 22 feet below the level of the boiler house, a very striking departure from general practice, but a glance at the illustration will show that there was practically no other arrangement possible. The steam raising plant consists of two Babcock boilers, each of 120 H.P., mechanically stoked by Bennis stokers. A Green's economiser of 96 tubes is in use. The chimney shaft is of an octagon shape, is 60 feet in height, and built on the solid rock at the edge of the cliff. As we have already said, the engine room is cut out of solid rock, the engines being placed on the rock foundation. There are two Browett and Lindley engines, similar in most respects to those at Coventry. They are of the horizontal type, and are steam jacketed. They run at 250 revolutions per minute, and each engine is provided with a driving wheel of 48 cwt., and having a 19-inch face. The pulley on the dynamo weighs 33 cwt., and is driven by an 18-inch Eureka belt. The dynamos, of which there are two, are of the Westinghouse 6-pole type, having an output of 100 kw.; there is on each a worm gearing, for moving the brushes. The switchboard is practically a smaller edition of the one used on the Coventry tramways. It is divided into two marble panels, on which is fixed the usual apparatus, such as main feeder, switches, automatic circuit breaker, and Weston's portable voltmeter. There is also apparatus for controlling the station lighting, which, by the way, is done from the trolley wire. Sufficient storage exists in the boiler house for 100 tons of coal. Some idea will be gained of the power-house from the illustration, which is reproduced from a photograph taken when the boilers were in position, but before the building had been completed. The pump-room is 12 feet below the floor of the engine-room, and here

Power House in Course of Construction.

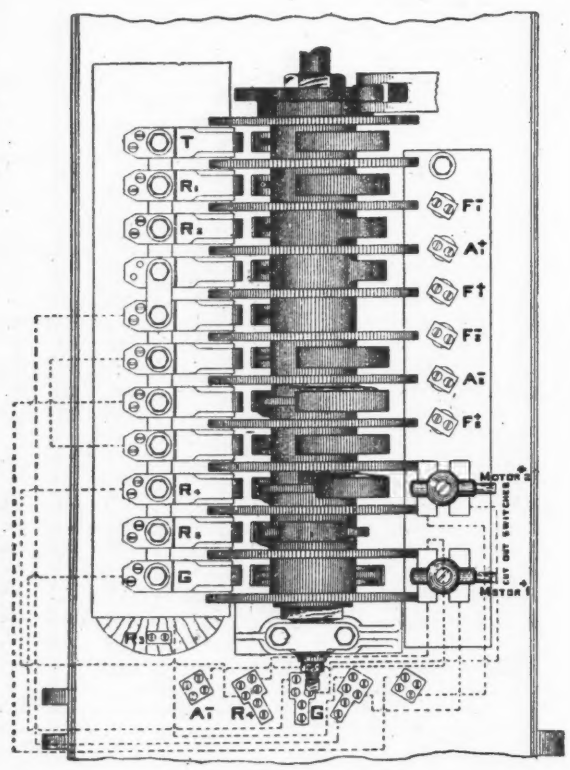
are two Westinghouse pumps for feeding the boilers either through the economiser or direct. In addition, there is a Ledwards combined circulating and air-pump. Water is obtained from the adjoining Pigeon Stream, but as it runs rather low in the summer a Worthington pump is placed down by the sea for the purpose of furnishing water for the condenser.

Already the line has been extended beyond what was originally projected, it being a quarter of a mile nearer Douglas than was at first intended. It is highly probable that the line at the other end will be carried further, there being quite a short distance between the present terminus and Port Soderick. An extension in this direction, however, will necessitate an embankment across the Keristal Valley.



One of the Motor Cars.

The whole of the work has been carried out by the New General Traction Company, Limited, the resident engineer for the contractors being Mr. H. Lavington Fletcher, who superintended the construction of the Coventry tramways; his assistant at Douglas is Mr. Pritt, who was also associated with the Coventry tramways. We have to thank those gentlemen, as well as Mr. Winslow, of the New General Traction Company, for the assistance given in compiling this preliminary notice. Some of the illustrations have been prepared from photographs kindly lent to us by Mr. Fletcher, Mr. Lynn, the local manager of the line, and Mr. E. L. Benjamin, a member of the staff.



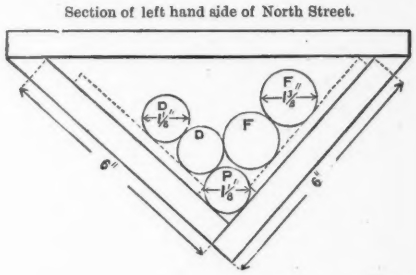
Connections of Controller.

A NEW SYSTEM OF STREET MAINS.

The following description of street mains, which are being laid down at Guildford by Messrs. Sharp & Kent, will be interesting to our readers.

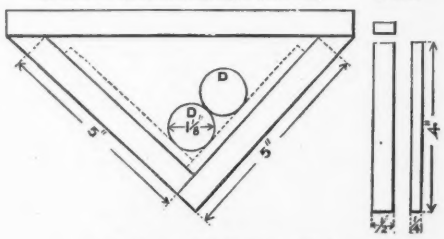
The distributing mains are laid on what is known as the safety concentric system of wiring, that is to say, each cable carrying current is composed of a copper core insulated in one of the well-known ways, and having served on it an outer conductor of stranded iron wire, which wire serves for the return current and is not insulated. The three-wire system is used, the difference in potential between either core, wire and the armour which serves as the third wire being 200 volts. Any main, therefore, consists of two safety concentric wires laid side by side, the armouring of the two wires being uninsulated and being used as the third wire of the system. Although the wires are uninsulated, they are protected from possible electrolysis by being first of all served with a light protecting covering of bituminous jute and then laid together in a V-shaped trough which is filled in with bitumen. Suitable distance pieces are inserted in the trough at short intervals to prevent the cables sinking through the bitumen to the bare wood of the trough. The wire that is being used is manufactured by Messrs. Callenders' Company, the armouring being on the patent lock coil system, which practically makes the cable watertight. There will be no service boxes, all joints being made direct on to the cable by means of a special cast joint and then buried in the ground.

Section of left hand side of North Street.

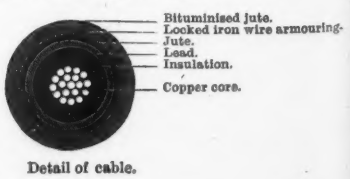


Section for all streets having 2 wires only.

Detail of distance pieces.



F, Feeder; D, Distributor; P, Pilot.



Detail of cable.

The feeders themselves are insulated throughout their entire length. Fig. 1 shows a section through the ordinary network. Fig. 2 shows a section through a trough containing, besides the network, pilot wire, and a pair of feeders.

ELECTRIC LIGHTING NOTES.

(*Continued from page 76.*)

Bray.—We hear that the reports of Mr. R. Hammond and the resident engineer (Mr. George M. Harris), with reference to new plant and proposed alterations at the central stations, have been received. Tenders for the new buildings are to be invited, and orders for the plant given out.

Bristol.—The usual local Government Board inquiry will be held shortly, regarding the £75,000 loan for electric lighting extensions. A main is to be laid from White Ladies Road through Cotham Hill and Woodland Road to Highbury Chapel and University College Road.

Bury St. Edmunds.—At Tuesday's meeting of the Town Council, the report from the Electric Lighting Committee, presented at the last meeting, recommending the adoption of an electric lighting scheme, came on for consideration. The report, after a long discussion, was carried by 13 votes to three, six remaining neutral.

Calcutta.—We see, says *Indian Engineering*, our daily contemporaries, in announcing that Messrs. Kilburn & Co. propose to supply electricity both for the purposes of the Calcutta tramways as well as for lighting, give them the credit for the work now in progress at the Alipur Jail and Belvedere. But Messrs. F. & C. Osler have been entrusted with it, and are pushing it through with all possible speed.

Coventry.—A Local Government Board inquiry is to be held here on the 21st inst. with respect to an application by the Corporation for a loan of £13,000 for electric lighting extensions.

Cowes.—The Provisional Order for the electric lighting having been granted to the District Council, the Electric Construction Company has inquired whether it may anticipate being favoured with the order to proceed with the work in accordance with the specification and tender submitted on August 26th, 1895. The communication has been referred to the Lighting Committee.

Dorking.—The District Council has come to the conclusion that better lighting is needed for the Dorking thoroughfares, and the question of incandescent gas *v.* electric light is before it. The Guildford Electricity Supply Company has given notice of its intention to apply for a provisional order.

Ealing.—The District Council have decided to greatly extend and almost double their electric lighting works in the Ealing road, and one of the contracts for the work, which will cost nearly £5,000, has fallen to Messrs. W. Foord and Sons.

A resident in Waldeck Road has applied to have the electric light supplied, but as his was the first application from Waldeck Road, an extension of the mains could not be entertained until there were other applications.

Exeter.—At a meeting of the Council last week, the Special Committee reported that the question of supplying the electric light to the Devon and Exeter Hospital had been considered. They recommended that the price to be quoted to the hospital be at the rate of 6d. per Board of Trade unit on the power supplied, subject to the following discounts: 25 per cent. discount if a *bonâ fide* all-night supply is taken; an additional discount on half-yearly accounts, provided the amount of such account is paid within one month of its delivery; up to £10, a discount of 5 per cent.; up to £25, a discount of 7½ per cent.; up to £50, a discount of 10 per cent.; up to £100, a discount of £12½ per cent.; £100 and above, a discount of 15 per cent. The surveyor reported on additions to the electric light works necessary for the coming autumn and winter, and the committee resolved that they be carried out. To a proposal that the report be adopted, the following amendment was submitted:—"That no portion of the amount sanctioned by the Local Government Board for extensions and improvements in connection with the electric light undertaking be expended until the opinion of an expert, as to the advisability of such expenditure, has been obtained." After a discussion, the amendment was lost by a large majority, and the committee's report adopted.

Fulham.—The Electric Lighting Committee recently reported as follows to the Vestry:—"We beg to report that we have again very carefully considered the report of Mr. F. H. Medhurst on refuse destructors and electric lighting, and recommend that a deputation be appointed, consisting of the chairman, vice-chairman, and four members of the committee, with Mr. Medhurst, our electrical engineer, the medical officer of health, and the surveyor, to visit the towns of Leeds, Warrington, Oldham, Brighton, Bedford, and Portsmouth, for the purpose of seeing the destructors in operation, and inspecting the electricity supply works. That Messrs. Baxter, T. Davies, Tapp and Lerry do form the deputation, and that the expenses do not exceed £100." After some discussion, the matter was referred back to committee.

Hammersmith.—The Vestry is to apply to the London County Council for sanction to the borrowing by the Vestry, and for the advance of £41,046 for the electric lighting and other purposes.

Hampstead.—Additional high tension feeders are to be laid down from the central station to a number of sub-stations, at an estimated cost of £787 14s. 2d. for cable. The engineer has been instructed to adapt one of the existing street gas lamps for incandescent electric lighting, and try the same as an experiment; also to try the effect of using Welsh coal at the station for a period of 14 days. A clerk of works for the extension of the central station is to be appointed.

Harwarden.—A firm of electricians has given information as to the electric lighting of the village, which was spoken about at a recent Council meeting.

Hull.—The Finance Committee last week again considered the estimates for the electric light extension. The chairman of the committee, after the discussion had continued for some time, promised to discuss the matter with the Borough Treasurer.

Inverness.—The County of London and Brush Provincial Electric Lighting Company intend to make application for a provisional order. The Council postponed discussion on the question until the August meeting.

Islington.—The Vestry has before it a proposal—which is opposed—to appoint Mr. Gay as the electric lighting engineer during the pleasure of the Vestry at a salary of £500 per annum, as from January 1st last, with further increments of £50 as from January 1st, 1897, until a maximum salary of £600 per annum is reached. Mr. Gay at present receives a salary of £400.

Kingswood.—The electric light contractors now state that they are willing to allow the offer to purchase to remain open a little longer.

Lambeth.—At the last vestry meeting the Electric Lighting Committee presented a long report upon the attempted settlement of the contract with Mr. Sax, in which they suggested certain modifications of the terms. These revisions had not, however, been agreed to by Mr. Sax, and it was understood that a further report would be made.

Levenshulme.—The South Manchester Electric Supply Company and the Altrincham Electric Supply Company have intimated their intention to apply to the Board of Trade for provisional orders for lighting the district. A committee has the matter in hand.

Leyton.—A large number of applications have been received for the post of resident electrical engineer. Six of the applicants have been requested to appear before the Council. Prof. Robinson states that if there is no delay, the light ought to be supplied by the middle of August.

London.—Messrs. Rashleigh Phipps & Co. are at present engaged upon the electric lighting of Holy Trinity Church, Paddington, where they are installing nearly 200 lights. This firm has also recently lighted electrically St. John's Church, Southwick Crescent, Dr. Pentecost's Church, Upper George Street, and additional lighting at Christ Church, Lancaster Gate. Messrs. Rashleigh Phipps & Co. are engaged upon the electric lighting of a large block of flats, Artillery Mansions, Victoria Street, Westminster; also the installation of nearly 1,000 lights at Horrex's Hotel in the Strand, and have in hand a large number of country installations at Dartford, Farnham, Shenley, Herts, Edenbridge, Kent, where oil and steam engines are being erected in connection with the lighting.

The order for the electric lighting of the National Gallery of British Art now being built on the site of the Millbank prison by Mr. Tate, has been placed in the hands of Messrs. Drake and Gorham, who are employing Russell's patent system of wiring throughout the building. Mr. C. N. Russell, whose agreement with the London and Lancashire Electric Company has terminated, has joined Messrs. Drake and Gorham's staff, and is personally supervising the work at this important installation.

Londonderry.—The Corporation wants a dynamo attendant. For further particulars see our "Official Notices."

Mile End.—There was quite a lively time at the last Vestry meeting when the electric lighting question came up. Two members disagreed; from this they childishly got to personalities, and ultimately engaged in a free fight on the floor of the Hall. They may have thought this a simple way of settling the electric lighting question, but the majority did not agree to this course, for the chairman and other vestrymen had to intervene before the pugilists would "make it up."

Monkton Combe.—At the last District Council meeting Mr. Montagu introduced the question of the lighting of Combe Down and said he had had an interview with Mr. Freeman, who had an installation of electric light at his mills; but the sub-committee were not yet prepared to report as to the expense of the electric light, or in what way they should endeavour to carry it out. They desired to consider the possibility of lighting Monkton Combe as well, and he hoped and believed they would find it practicable, and that it could be done cheaper than the amount they were now paying for public and private lighting. He had been round the district with an electrical engineer, but he had no figures to show, neither had he come to any sort of conclusion to recommend such a course. He moved a resolution to the effect that the gas company be approached before the Parish Council proceed further in the inquiries into the electric lighting.

Newington.—At the last meeting of the Vestry, the electric lighting question was again raised. A statutory notice had been received from the County of London and Brush Provincial Electric Lighting Company, Limited, of their intention to apply to the Board of Trade for a provisional order. The matter was, after discussion, referred to the Electric Lighting Committee. It was also resolved, "That Messrs. Kincaid, Waller, and Manville be engaged for a fee of 50 guineas to prepare a report dealing with the system of electrical distribution best adapted for Newington, the capacity of the station, the capital cost, the distributing mains, the revenue reasonably to be derived, the cost of maintenance, statistics from all municipal undertakings to date, and all necessary assistance in making a fresh application for a provisional order, should the Vestry decide to apply to the Board of Trade for same; and in the event of such application being made, and a provisional order sanctioned by Parliament, such fee of 50 guineas to merge into the usual 5 per cent. for preparation of plans, specifications, and supervision of works to be carried out under the order, it being distinctly understood that the only extra fees payable in excess of the agreed fee will be in respect of attendances in the event of a Board of Trade inquiry, and the ordinary out-of-pocket expenses for telegrams, cab fares, postage, and such like expenses."

Plymouth.—The Corporation want a draughtsman and assistant to the borough electrical engineer, over 25 years of age, at a salary of £150, rising to £200. For further particulars see our "Official Notices."

Salford.—The charges for current in future will be 6d. per unit for lighting and 3d. for motive power.

Ship Lighting.—On June 30th, the ss. *Albertville*, built to the order of the African Steamship Company, London, for the Compagnie Belge Maritime du Congo, by Sir Raylton Dixon & Co., of Middlesbrough-on-Tees, went to sea on her trial trip. The *Albertville* is supplied with combination fittings of oil and electric light, arranged over each table. A very complete system of electric light has been installed by Messrs. Paterson & Cooper, under the supervision of their engineer, Mr. E. George Tidd, A.M.I.C.E., A.I.E.E. The system might be called a sub-distributing two-wire system. The following points are claimed for this system:—1. No connection is made to the hull of the vessel. 2. No joints are made in wires or cables throughout the whole installation. 3. No small fuses are scattered about throughout the vessel, but are all kept in clusters in convenient positions. 4. All fuses are double-pole, thus rendering the location of a fault much easier. The general scheme of wiring is as follows:—The mains are carried without branches to the main switchboard; here the current passes through the ammeter and voltmeter, and is divided into the requisite number of circuits. These circuits run again without joint or branch into the main terminals of sub-distributing boards placed in a convenient position in each department of the vessel. There the current is again sub-divided into about four sub-circuits, each circuit being controlled and protected by double-pole fuses and switch. From these various distributing boards the sub-circuits again run without branch or joint to sub-distributing boards placed centrally with the lamps they are to control. These sub-distributing boards are fitted with double-pole fuses, one pair for each incandescent lamp, and from these fuses the lamp leads run direct to the lamps. In this case the switch is, of course, placed near the lamp, and not on the fuse board. The plant consists of a 14½-inch × 13-inch compound-wound dynamo, by Paterson & Cooper, capable of giving 14,400 watts in the external circuit. The makers' well-known speciality in connection with the brush-holders and adjusting gear are fitted, as are also the most recent improvements in building up the armature and commutator. The magnets are so arranged that one limb can be removed so that the armature can be taken out sideways, as, as is generally the case on steamships, there is not room to draw it out longitudinally. The dynamo is mounted on the same bedplate, and coupled direct to a Robey vertical inverted cylinder electric light engine, cylinder 8½-inch × 8-inch stroke, running at 300 revolutions per minute. The switchboard is mounted on the bulkhead at the back of the dynamo; it is of neat design, and fitted with Paterson & Cooper's latest type of ammeter, voltmeter, and switches. In each of the five departments for which circuits are provided, distributing switchboards are fitted, on each of which boards one circuit controls certain lights in passages, lavatories, &c., that are needed throughout the night. These switchboards divide the current between the necessary double-pole fuse boards. As explained above, joints are entirely avoided throughout the installation, and every lamp, sub-circuit, and main circuit is provided with a double-pole fuse. Special care has been taken with the mast and side lights, which are under the control of the officer in charge of the wheel-house. The supply is run direct from the engine room, and is connected to the same switch, so that anything going wrong with that circuit would at once be noted by the engineer on duty. The whole of the work has been carried out in strict accordance with the rules and regulations issued by Lloyds Register of British Shipping, with whom the boat will be placed under their highest class. The boat has been built under the superintendence of Captain Rattray, the owners' marine superintendent, and the engine room and auxiliary department has been in charge of Mr. Alder, superintending engineer for this line of steamer.

Shoreditch.—There having been considerable delay in laying the mains, an extra gang of workmen, and an additional permanent foreman, are to be engaged.

Southwark.—The Evelina Hospital for Sick Children in Southwark Bridge Road is to be lighted by electricity.

Stockton.—The Board of Trade has extended the provisional electric lighting order for a further period of two years.

Stafford.—The mains are to be extended along Martin Street to Eastgate Street.

Swansea.—The Markets Committee has decided to recommend the Council to ask Mr. J. S. Brown and Mr. Legge to tender for the electric lighting of the market according to specification.

Torquay.—The Guildford Electric Supply Company has given notice that it intends to apply for a provisional order for lighting the district.

On 10th inst. a Local Government Board Inquiry *re* application of the Council for power to borrow £23,000 for electric lighting was held. Mr. W. H. Trentham, the electrical engineer who had reported, and Mr. E. Manville, gave evidence for the Town Council. There was a vigorous opposition party.

Wakefield.—The West Riding County Council has adopted the recommendations of the General Purposes Committee that plant should be laid down for generating electricity for steam in combination with the heating system at the new County Council offices at an estimated cost of £995 for plant, and £850 for storage battery; that wiring in insulated iron tubes should be adopted at a cost of £1,527 10s., instead of surface wiring in wood casing at a cost of £800, as originally estimated; that inter-telephone communication should be provided throughout the offices and committee-rooms at an estimated cost of £270, instead of £75 as previously estimated. There was a discussion regarding the use of the iron tubing, instead of wood casing, the immense cost being specially referred to, and several members regarded it as a luxury.

Walsall.—A number of residents in High Street and Digbeth having petitioned the Council for an extension of the mains through their district, a committee is considering the matter.

Watford.—Mr. W. Hawtayne is to advise the District Council in regard to the application for a provisional electric lighting order.

Wolverhampton.—At the last meeting of the Council the Mayor, in moving the adoption of the report of the Lighting Committee, thought it would be a source of satisfaction to the Council to know that the first complete year's working of the electric light had resulted in a loss of £241 only, which was equivalent to 0·68 per cent., a very small loss indeed. As a matter of fact they had, as a trading concern, made a profit on the capital of 4·85 per cent. He proceeded to give a comparison of the cost of the gas and the electric light since its introduction in the Art Gallery, the School of Art, the Free Library, and the Town Hall, and also one or two large manufacturers in the town, from which he showed that on the whole the new light was the cheaper. In the case of a large consumer, a member of the Council, gas at 2s. 9d. per 1,000 cost him 19s. 7d. per burner per annum. His electric lighting bill for the year ending March last was 19s. 3d. per light.

Yarmouth.—The statement of the borough surveyor for last month shows a cost of working over income of £11 9s. 6d., to which must be added about £100 for interest, repayment of capital, charges, &c. In his report to the Council, however, he expresses himself confident that the steadily increasing demand would soon convert the loss into a profit, the number of lamps now installed being nearly 8,500. There had been a loss on the last six months working of £335, but he anticipated that next year no loss would fall on the rates.—Mr. W. H. Preece, who attended the committee meeting, hoped that as the cost of working was lowered the public lighting would be remunerative.

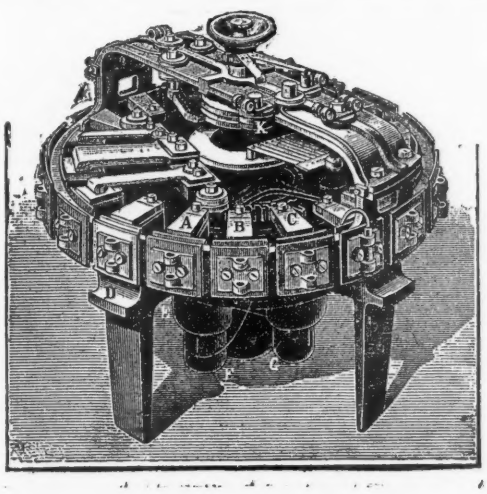
ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belfast.—The question of electric street tramways for Belfast came up on 6th inst. before the judicial committee of the Privy Council. The promoters of the scheme—who are seeking by Bill in Parliament to obtain power to use electricity on their lines—applied for permission to double the lines outside the city of Belfast. The Belfast Municipal Council had postponed from time to time any decision on the matter of doubling the lines within the city. The application to the Privy Council was for permission to double the lines outside the city, and this was granted, subject to slight modifications.

City and South London Railway Extension.—The City and South London Railway Bill came before the Select Committee of the House of Lords, presided over by Lord Connemara, on Monday. Mr. Pembroke Stephens, Q.C., in opening the case for the promoters, said the object of the Bill was to extend the time for the completion of the construction of the company's line from Clapham to the Angel at Islington. The works had already received the sanction of Parliament in 1891, 1892, and 1893. They contemplated the acquisition of the church of St. Mary Woolnoth, at the junction of King William Street and Lombard Street. No objection had been raised to the proposed demolition of the church in the early years of the proposed works, but in 1895 the Home Secretary, having reported to Parliament that probably it would not be necessary to interfere with the fabric, the acquisition of the crypt alone being sufficient, an

agitation was started for the preservation of the church. The company's Bill was contested in the Commons, the Committee of the Lower House being required, by instruction, to consider whether that St. Mary's Woolnoth should be demolished. The Committee passed the preamble of the Bill, deciding, however, that the fabric of the church should not be interfered with, but that the company should receive consideration for the special expense they were put to in excavating in the crypt and the ground adjoining the church, without doing injury to the fabric.—Mr. Greathead, the well-known engineer, was put into the box on behalf of the promoters, and was under examination when the Committee adjourned.

A Surface Rail System.—In describing the Pringle and Kent surface rail systems in our issue of July 3rd, we mentioned that there was a good deal of resemblance between it and that known as the Claret Vuilleumier, which is being used in Paris at the present time. The following account of the Claret Vuilleumier distributor is taken from *La Nature*. There are 20 contacts or feeding points on each distributor. It carries a central arm kept constantly in communication with the cable coming from the station with the aid of suitable connections. This arm, by taking up different positions, establishes contact successively on each block, and consequently on the metal studs upon the passage of the car. At Lyons the displacement of the arm, and its arrival at the different blocks, were obtained by means of an electro-magnet which came into action upon the arrival of a car. It then set free a clockwork arrangement which dis-



placed the contacts. In the new arrangement, two electro-magnets, F and G, one for the outgoing and one for the return journey, also come into action at the moment of the arrival of a car. A diametrical rod, bearing contacts at its extremities, is attracted by an electro-magnet, and is brought against a ratchet held by a spring. This ratchet enters the indentation of a toothed wheel, which is set in motion, and displaces the arms on the blocks, A, B, C, conveying the current to the metal studs. This operation is carried out on all the blocks in succession. In order to pass from one distributor to another the two last metallic studs corresponding to this distributor are connected with the two first blocks of the one following. At D are the holes through which the cables pass communicating with the metallic stud. It is easy, by a simple manipulation, to insert and withdraw the rods.

Cork.—A special meeting of the Public Works' Committee of the Cork Corporation was held on 9th inst. to consider the amendments to the draft order in Council of the Cork electric tramway scheme. A number of amendments were decided on.

Cost of Steam and Electricity.—It is interesting to observe that, prior to the construction of the third rail on the Nantasket line, two steam locomotives were employed over that section of the line 3½ miles long. These two locomotives consumed 4 tons of coal per day, while the total amount of coal burned in the power-house, which now operates seven miles of line, including the section over which the steam locomotives ran, does not exceed 4 tons per day. A few more facts like these, and electric traction will progress even in this country.

Glasgow.—The Tramway Committee held a special meeting on 8th inst., to consider the report of a sub-committee in recommendation of an experimental trial of overhead electric traction on the Kelvinside and Dennistoun sections, at a cost of between £60,000 and £70,000. The matter was discussed at considerable length, but it was agreed not to come to any decision in the meantime.

Madras.—*Indian Engineering* says there is a rumour afloat that arrangements are now in progress which will enable the company to resume possession of the Madras Electric Tramways very shortly. Circumstances point in the same direction.

Mumbles.—A contemporary says that the question of adopting electric motors for the work of propulsion is being considered by the directors of the Mumbles Railway Company. The idea is to place a motor under each car. This was suggested by us eight or ten years ago.

The Nantasket Beach Railway.—About 12 months ago we drew attention to the successful introduction of electric traction on the Nantasket Beach Railway. The overhead wire system was adopted, but in a recent extension to East Weymouth, a distance of 3½ miles, the third-rail system has been introduced. The cars leave Pemberton and run with the trolleys as far as Nantasket Junction. The trolley is then pulled down and hooked, and the contact shoes at each end of the car strikes the third rail, the passengers being unaware of the change in the method of contact. During a recent test with the officials of the railroad on board, a speed of from 70 to 80 miles an hour was attained. On arrival at East Weymouth the car was switched over, and the return trip was made from East Weymouth to Pemberton in about 11 minutes, the distance being about 10½ miles. As our contemporary, the *Electrical Engineer*, of New York, observes, should the operation of this road prove successful, it is probable that the third-rail system will be extended as far as Braintree, a station 10 miles out of Boston, and if the success of the new method under the ordinary conditions of constant travel fulfils all expectations, suburban service throughout the country will probably undergo a change.

The London Tramways.—The *City Press* says that next week a report of the Highways Committee of the London County Council will be presented on this subject. The Committee adhere to their recommendation, that the Council should lease the lines to the two companies until 1910. They will report against the Council working the lines or using electric traction, and will adduce additional facts and figures in support of their recommendation, and against the instructions from the Council, carried at the instance of Mr. Baker.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Monte Alegre-Santarem ...	May 5th, 1896 ...	...
Bissao-Bolama	May 30th, 1896 ...	...
Cadiz-Teneriffe	June 7th, 1896 ...	...
Para-Maranhao	July 9th, 1896 ...	...
Lourenço Marquez-Durban ...	July 13th, 1896 ...	...

Telegrams may be sent *vid* West Coast route. Landline between Delagoa Bay and Durban in bad condition.

Landlines.		
Trans-Continental line beyond Mazol (Mashonaland)	March 12th, 1896 ...	...
Bolinao-Manila	March 19th, 1896 ...	...
Communication with Cartagena and Barranquilla, Columbia.	July 4th, 1896 ...	...
Siberian lines between Krasnoviarsk and Kransk	July 7th, 1896 ...	July 9th, 1896.
Communication with Charter Salisbury and all offices connected by Beira Railway telegraphs	July 9th, 1896 ...	July 10th, 1896.
Communication with the interior of Ecuador beyond Guayaquil	July 9th, 1896. ...	July 10th, 1896.
Communication with Cuenza, Machala, Santa Rosa, Laja, and Guaranda	July 10th, 1896. ...	...
Salisbury-Umtali, cutting off Beira	July 11th, 1896 ...	...
Communication with Quito (Ecuador)	July 15th, 1896 ...	...

July 15th, 1896: Berne notifies that Government censure on telegrams for San José, and places beyond that town in Guatemala, is abolished.

Cost of the Telegraphs.—In the House of Commons on Tuesday, Mr. Henniker Heaton asked the Secretary to the Treasury, as representing the Postmaster-General, whether he would state the total amount of the loss sustained on the telegraphs in this country since they were acquired by the State, including the amount for interest on the purchase money of such telegraphs; whether he would also give the total amount expended in the same period on the acquisition of sites for, and the erection of telegraph offices, and also the estimated total value of the said sites and offices at the present day; and whether the cost of acquiring the said sites and erecting telegraph offices had been defrayed from year to year out of current revenue; or if not, what amount had been defrayed out of current revenue. Mr. Hanbury said that the particulars asked for would be found in a Parliamentary paper, issued early in the session at the request of the hon. member. The total referred to in the first part of the question was £5,847,000. The proportion charged to the telegraph account for the cost of sites and buildings since the telegraphs were taken over, was £1,241,000. No estimate of the present value of the sites and buildings could be given without a special valuation in each case. The cost of acquiring sites and erecting buildings must be defrayed from the votes of each year.

Interruption of South African Cable.—We learn that the Lourenço Marquez-Durban cable is again interrupted, and that as the landlines between Delagoa Bay and Durban are in bad condition, all telegrams for South Africa must be forwarded by the West Coast route, which was recently repaired again, after being interrupted in May and June for some 20 days. These continual interruptions on the cable routes to South Africa have attracted much attention, owing to the disturbed state of political affairs, and we have no doubt that Her Majesty's Government, which, with other Governments, contributes heavy subsidies to the lines to South Africa, have urged on the offending companies the need of duplicating some, at least, of the worst sections of these cables. We publish below a note concerning the frequent interruptions which have occurred on the Australian landlines; this subject, however, is not brought prominently before the public, as it is only the commercial, and not the political portion of the community, which is put to inconvenience and loss; but, should any matter of great political importance arise affecting Australia, New Zealand, or New Caledonia, we venture to think that the inconvenience would be found as considerable in relation to Australia as it has recently been in regard to South Africa.

Interruptions to Australian Trunk Landlines.—We have frequently had to call attention to the periodical interruptions which occur on the two Australian trunk landlines connecting the present existing cable routes with the business portions of Australia, and also forming the only link of connection between Europe and New Zealand. As a rule little is known of the true state of these affairs in England, for though both are adherents to the International Telegraph Convention, under the rules of which such interruptions to international traffic should be reported to Berne, neither South Australia nor Western Australia carry out this portion of their agreement; at least so we conclude, from the fact that the Bureau International at Berne, while noticing the smallest interruptions or delays in other landline systems, is altogether silent concerning these frequent breakdowns which occur on the trunk lines in Australia. We now learn, through the Australian press of June 3rd, that communication on the Port Darwin line had been restored after being once more interrupted on June 1st. During the recent troubles in South Africa, the importance of even slight delay was clearly shown and understood; but as at present attention is not specially directed to Australia or New Zealand, these interruptions, of which we give a list below, have attracted but little attention.

1895.	
January 18th or 19th till January 25th	Port Darwin route interrupted. Western Australian route interrupted.
July 28th till 29th ...	Port Darwin route interrupted.
September	"Fault still exists in Western Australian line between Bremer and Esperance Bay. All business is much delayed."
November 12th ...	Western Australian route interrupted.
" 23rd ...	Western Australian route interrupted.
1896.	
January 14th ...	Port Darwin route interrupted.
" 18th till 19th	Port Darwin route interrupted.
January 22nd ...	Port Darwin route interrupted.
" 27th ...	Urgent business telegrams for Western Australia suspended.
February 18th till " 27th ...	Western Australian route interrupted.
March 13th	Port Darwin route interrupted.
June 1st till June 2nd	Port Darwin route interrupted.

From the above it will be seen that the Port Darwin landline, described as the only reliable means of communication through Australia, has been interrupted, on an average, once a month for the first five months of the current year; and still there are to be found representatives of the Australian colonies who profess themselves as being quite satisfied with the existing means of telegraph communication with Australia and New Zealand!

The Telegraph Wire Export Trade.—Judging from the returns which are now available regarding the exports of telegraphic wire and apparatus connected therewith from this country during last month, June has proved itself to be one of the quietest months so far this year, the exports having amounted to a value of only £19,680, as against £112,215 in the preceding month, and £99,572 in June last year. Notwithstanding the quietness last month, the half-year closes more satisfactorily than last year, although the trade is not by any means showing the briskness experienced in 1894. For the six months ending in June last, the exports attained a total value of £343,263, as compared with £226,260 in the corresponding period of last year, and £883,741 in the first six months of 1894.

CONTRACTS OPEN AND CLOSED.

OPEN.

Armagh.—August 3rd. The Commissioners for the Control of Lunatic Asylums, Custom House, Dublin, want tenders for the erection of an electric light installation for the Armagh Asylum. Particulars from the secretary.

Germany.—July 25th. Tenders are being invited for the supply and erection of the plant and fittings required for the electric lighting of the railway station at Bretten. Tenders to the General Direction of the Grosse-Badische Staats-Eisenbahnen, Carlsruhe.

Hull.—July 23rd. The Corporation wants tenders for the supply of an engine and dynamo for lighting the East District sewage pumping station.

Madras.—Nov. 11th. Lieut. Col. C. C. Rawson (in charge Consulting Architects' Division) invites tenders for the lighting by electricity of Government House, Madras, including the banqueting hall and the A.D.C.'s bungalow: also for the lighting of Government House, Guindy, including the Military Secretary's bungalow. Particulars to be obtained on application to the Consulting Architect to the Government of Madras, Chepauk, Madras.

Mexico.—August 31st. The Secretary of State for Foreign Affairs has received from the British Consul at Mexico, a pamphlet issued by the municipal council of that city, containing particulars as to tenders which are called for, for the public lighting of the city by electricity, and which must be put in by the last day of August, 1896. This pamphlet may be seen on application to the Commercial Department of the Foreign Office, between the hours 11-6.

Portugal.—July 22nd. Tenders are invited for the supply of 10,000 porcelain insulators, with galvanised iron supports, and about 2½ tons of galvanised iron wire. Tenders to be sent to the Chef du Service des Magasins de la Compagnie Royale des Chemins de Fer Portugais, Santa Apolonia, Lisbon.

CLOSED.

Plymouth.—The tender of the British Insulated Wire Company for the supply of the underground electric cables required for Old Town, Ebrington, and Ham Streets for £723, and that of Messrs. Doulton for the supply of stoneware conduits, &c., for the sum of £227, have been accepted subject to the approval of the Local Government Board.

Wakefield.—The Private Wire and Telephone Installation Company has secured the contract for providing and fitting telephones throughout the new municipal buildings at Wakefield.

NOTES.

Electrical Engineering in Russia.—The shipyard and engineering works which are being established at Nicolaieff, South Russia, under the auspices of the well-known Cockerill Company of Seraing, Belgium, are not only to be lighted throughout by electricity, but all the machinery is to be driven by electromotors. In connection therewith, a large central station is being erected of a total capacity of 1,000 H.P. The plant will consist of five sets each of 200 H.P., each set comprising a multitubular boiler, a 200 H.P. de Laval steam turbine, and a large Desroziers dynamo.

Why 110 Volts?—Our New York namesake doubts if there are more than three men living who know why the standard voltage of the incandescent lamp was made 110 volts. Edison knows, and in a recent conversation the reason for the 110 volts was disclosed. The inventor, in his early work on the lamp, always allowed 10 per cent. for errors, leakage, &c., and when one of his assistants suggested 100 volts, Edison said, "We'll add 10 per cent., as usual, and make it 110 volts." That settled it, and the standard has remained the same ever since.

Presentation.—On 9th inst. an illuminated address, a silver tea service and cigar case, was presented to Mr. J. Clifton Robinson by the employés of the Dublin Electric Tramway Company, on the occasion of his retiring from the managing directorship of the company. Mr. Robinson was absent in London, and the presentation was received on his behalf by Mr. T. B. Halliday, superintendent of the line.

Death of a Boy Electrician.—Under the heading, "Little Electrician Dies," a Chicago paper states that Henry Sevenga, the 13-year-old son of the electrician of Lincoln Park, died recently from injuries received by falling from an electric light pole. The boy had climbed the pole to fix a dimly burning light, when he touched a live wire.

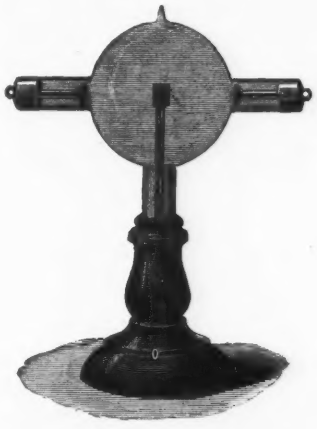
Accident to a French Water Tube Boiler.—Anyone who is interested in the navy (and who is not interested in this arm), will be anxious to obtain details of the disaster to the ironclad *Jaureguiberry*, belonging to our friends the French. This accident was simply a water tube split for a length of 290 mm., and seven men were killed. The *Jaureguiberry* is a large vessel of 11,824 tons, and is considered one of the best ships of the French navy. Its horse-power is 11,200 (chevaux), and its speed 18 knots. On June 2nd she was put upon her official test of consumption of 24 hours duration, and was returning to Toulon when the tube in question gave way, and in a few seconds steam filled the stokehold, and seven men died. The tube was one of the lower tubes, near the out part of combustion chamber, and rupture seems to have occurred at the weld. Besides the long rip were also three others, but of no consequence, though they would very soon have been of consequence had the main rip not relieved them of pressure. While it appears that the weld was defective, rumour has also to say that for reasons of economy the tubes had simple welds, and were not welded spirally. The boilers are of the Lagraffel and Allest type. In January, 1894, a similar accident occurred on the torpedo vessel *Sarragin*—one of the agile class—to a Babillot boiler. A tube ruptured for a length of 310 mm. by 70 mm. at the weld. The accident put a ban on the type of boiler, and its place was taken by the Normand or Du Temple type, but our contemporary thinks the confidence of engineers may well be shaken, and instances the *Arethuse* and the *Branderburg*, in which latter 40 men were killed, as examples of the need for care in the construction and inspection of warships. We are strongly of opinion that in our own navy far too little consideration has been given to the question before concluding to adopt water tube boilers on so large a scale as we have witnessed in the *Terrible*.

Electric Launches.—Writing of the points in favour of electric launches, *Electrical Engineering* says although only one type of launch was shown at the New York Electrical Exhibition, yet its graceful lines, the ease with which it may be handled, the absence not only of smoke and soot, but of all noise and all vibration, appeals to the millions of passengers that these boats have carried in the last four years. Street railway companies have found it profitable to encourage and aid in the introduction of these boats, as the necessary current for charging the cells may be supplied at an hour when the load line is at a minimum, thus necessitating little appreciable expenditure even of fuel. The amount of energy necessary to charge the storage cells placed beneath the seats of a 36 feet boat is 3 kilowatts, or 4 horse-power at 120 volts and 25 amperes per hour for 14 hours' service. These boats cost from $2,100 to $2,700 each.

A Novel Venture.—In a communication to the *Street Railway Journal* on the subject of "Attractions for Pleasure Resorts," the president of an U.S. railway company gives the experience of his company in a novel direction. The company laid out an extensive stretch of country as woods and a park for the purpose of getting more traffic, and the experiment has been quite a success. On the lake the company has an electric launch and row boats, which are well patronised in the summer season, and in the winter there is skating. It requires very little care to keep the electric launch in good condition. It is charged from the company's feed wire along the electric road.

Gas Motors for Tramways.—On Saturday a new line of tramways was formally opened, upon which cars driven by gas are running. This line extends from Blackpool through St. Anne's to Lytham. The system is the invention of the late Herr Lührig, of Dresden, and it has been improved by Mr. Holt, of the firm of Crossley & Co. A gas engine of the "Otto" type is placed under the car, the gas for which is compressed and carried in cylinders. The inventor claimed that it is considerably cheaper than the cheapest form of electric traction. Two lines worked by the system are now in successful operation at Dresden and Dessau. On Saturday trial trips were made. A party of gentlemen left London for Blackpool on Friday afternoon, and on Saturday morning they were joined by the Mayor of the town and others to witness the trials.

A New X Ray Tube.—The Allgemeine Elektricitäts-Gesellschaft, as a result of exhaustive experiments, has produced an X ray tube, which is of a handy form, and is said to be very effective in its action. The construction and form of this tube may be seen from the figure, which will be understood with a few words of explanation. The tube has three electrodes; the two outer terminals lead to concave discs, from either of which the cathode discharge may be directed on to a reflector supported in the centre of the tube, and connected to the third terminal. When the maximum effect is required, the reflector is connected to the positive terminal of the coil. The tubes are made for different spark lengths. A tube with a 3½ cm. spark length will produce a photograph of a hand, with an exposure of 2 minutes, at a distance of 10 cm. from the plate. The Allgemeine Elektricitäts-Gesellschaft has also constructed a tube to work with a large induction coil, giving a 20 cm. spark. With this tube they have succeeded in showing on the phosphorescent screen, the thickness of the shell of the skull of a young man of 17; also his vertebral column, ribs and



shoulder bone, and what is most important of all, the heart and its action, as well as the process of breathing. The thickest parts of the body can be photographed by this tube in a few minutes. Exact figures for the time of exposure cannot be given, since that depends on many circumstances, for instance, on the kind of brake on the coil, and on the constitution of the bodies being exposed. The tube, as the figure shows, is of a convenient form for handling, and requires no separate stand. This new German tube appears to be well worked out in detail; but it is evidently in principle a slightly modified form of the focus tube, which, though it has now been in use in England for several months, appears to have only just been discovered in Germany.

King's College Conversazione.—On Thursday, July 9th, the distribution of prizes took place in the central hall of the college in the presence of a large number of students and friends, the presentation being made by Viscount Cranbourne. The hall, under the superintendence of Prof. Holden, director of the Fine Arts Section, had been specially draped and decorated for the occasion. After the ceremony, the Principal, the Rev. Dr. Wace, and the members of the college staff held a reception. Dr. Wace received the guests in the entrance hall, and the rooms of the college were thrown open for their entertainment. There was no lack of variety in the amusement provided, which ranged from the music of a military band to abstruse scientific demonstrations by erudite members of the staff of the college. The laboratories, museums, and studios were thrown open, and an interesting display of apparatus, pictures, statuary, photographs, glass, and enamelled ware was set out for inspection, and Prof. Vernham and Mr. E. F. Horner gave organ recitals at intervals in the college chapel.

Shock Fatality.—A man named Hillard, who was engaged repairing the switchboard in the dynamo room at Rochester, New York, electric light station, received a shock which resulted in death.

Personal.—Mr. Vesey Brown, who secured the Lincoln appointment, and was afterwards offered increased salary by the Sunderland Town Council, has, we understand, decided to go to Lincoln, as he has no honourable alternative. The Sunderland post will therefore shortly become vacant.

A farewell supper was given on the 9th inst. at Bratzils Hotel, Kingston, co. Dublin, on the occasion of the departure of Mr. R. Woof, late superintendent engineer of the Dublin Electric Tramways, for London. Mr. Woof, who is an engineer of the British Thomson-Houston Company, has successfully piloted the Electric Tramway from its inauguration up to the present time, is leaving Dublin shortly to take up important constructional work in London for the above company. During the evening a presentation was made to Mr. Woof on behalf of the generating and maintenance staff by Mr. R. Humphries, assistant engineer of the tramway. The present took the form of a handsome travelling bag with silver mounted dressing case fittings.

The American Institute of Electrical Engineers has appointed Mr. Charles S. Bradley and Dr. Frederick Bedell as its representatives at the International Congress of Electricians to be held at Geneva in August.

Mr. A. H. Vesey asks us to announce that he has relinquished his private practice as a consulting engineer and joined Messrs. Vaughan & Brown, Limited, in a similar capacity.

Mr. W. Lowry, having severed his connection with Messrs. C. Mellier & Co., with whom he was for five years engaged as electrical engineer, has now assumed charge of the electrical department of Messrs. W. Turner, Lord & Co., of Mount Street, Grosvenor Square.

Injuries from Shock, but not Electric.—At a meeting of the Town Council on Tuesday, the Electric Lighting Committee presented a report from Major Cardew, R.E., Board of Trade inspector, with reference to a recent explosion near an electric light column at Southsea, in which he expressed an opinion that a cabman's injuries did not result from an electric shock, but that probably his nerves were affected by fright. Some members dissented, but Ald. G. Ellis, chairman of the Electric Lighting Committee, remarked that Major Cardew and Lord Kelvin had both given their most careful consideration to the matter, and their opinion, which coincided, must be regarded as absolutely correct.

X Rays.—A Chicago exchange says that Stephen J. Field, associate justice of the Supreme Court of the United States, has had an experience of three-quarters of an hour under Röntgen rays in San Francisco. Justice Field is troubled with an affection of the knee joint, which his physicians could not exactly define. The negative showed that the tibia and the femur have almost grown together. The joint is practically solidified. The bones have not that clearness of outline shown in the normal knee. The result is a very gratifying demonstration of the value of the X-ray as a means of disclosing the nature, location and extent of interior lesion.

The Röntgen Rays.—The annual general meeting of the Victoria Institute was held on Wednesday at the rooms of the Society of Arts. Sir George Stokes was in the chair, and among those present were the Lord Chancellor, Lord Kelvin, and Mr. Crookes. After the report had been read, Sir George Stokes gave an address on the Röntgen rays, and described at considerable length the work which led up to Röntgen's discovery.

Inhalation of Ozone.—A marked case of "Leucocythæmia, and its Treatment," is dealt with in the *Lancet* for May 9th, by Dr. Richard J. Cowen. The treatment consisted of the inhalation of ozonised air for certain lengths of time daily, a modification of Andreoli's apparatus being used for the purpose.

Lectures.—It is announced that at the University of North Wales, Bangor, Prof. Andrew Gray, LL.D., F.R.S., will next October begin a course of instruction in electrical measurement and practical electricity. For further details, see our "Official Notices."

More Honours for Lord Kelvin.—Lord Kelvin was introduced to the presence of H.M. the Queen on Wednesday, attended by the Secretary of the Order carrying the Insignia, when the Queen invested him with the Riband and Badge of a Knight Grand Cross (by placing the Riband over the right shoulder obliquely to the left side) and affixed to his Lordship's left breast the Star of the Order.

New Book on Submarine Cables.—We have before us a circular which is being sent out by Mr. Charles Bright, regarding his book on "Submarine Telegraph Cables: Their History, Construction, and Working." Messrs. Crosby Lockwood & Co. have arranged to publish the book, provided a sufficient number of copies are subscribed for at two guineas per copy. We hope there may be found a sufficient number of subscribers to warrant the publication of a book which is the only one of its kind.

Technical Education.—From our "Official Notices" particulars will be obtained of the Technical Day Classes in Mechanical and Electrical Engineering, which will commence on September 29th next at the South West London Polytechnic Institute.

The Canary Cable.—A Madrid despatch, dated 15th inst., says that the ss. *Dacia* has successfully fished up the broken ends of the cable to the Canary Islands.

Vacant Appointments.—From our "Official Notices," particulars of several vacant appointments at the Northampton Institute will be obtained.

NEW COMPANIES REGISTERED.

Verity's, Limited (48,698).—Registered on July 9th, with a capital of £2,000 in £1 shares, to carry on the business of cycle manufacturers, and of electrical engineers, and to carry on any other similar business which may seem desirable to the company. The subscribers (with one share each) are:—B. Verity, 39, Oakhurst Grove, East Dulwich, engineer; J. Steward, 7, Saltoun Road, Brixton, S.W., secretary; W. J. Alford, 10, Danby Street, Peckham, S.E., accountant; H. Marlow, 29, Finsbury Park Road, N., engineer; R. W. Edkins, 32, Underhill Road, East Dulwich, S.E., clerk; W. C. Keotes, 22, East Dulwich Grove, S.E., engineer; J. S. Millsted, 128, Queen Victoria Street, E.C., manufacturer. Registered without articles of association by B. Verity, 39, Oakhurst Grove, East Dulwich, S.E.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Reuter's Telegram Company, Limited (19,090c).—This company's annual return was filed on June 17th. The capital is £100,000, in £8 shares; 11,839 have been taken up, the full amount called, and £94,712 paid.

West India and Panama Telegraph Company, Limited (11,116).—This company's annual return was filed on June 10th. The capital is £2,445,630, in £10 shares) of which £200,000 are ordinary, 34,563 first preference, and 10,000 second preference); 88,321 ordinary, all the first preference, and 4,669 second preference have been taken up, £10 per share called, and £175,530 received.

CITY NOTES.

Manchester Accounts.

The electric lighting accounts of the Manchester Corporation must be very encouraging to the advocates of municipal enterprise. As we have already mentioned in these columns, the magnificent profit of £11,138 has been made, and the working costs are about the lowest in the country. The following extracts from the Committee's report shows the progress that is being made:—

"The number of consumers at the close of the year was 1,149, being an increase of 407, as compared with the previous year. The number of lamps connected was—incandescent 89,294 (of 8 candle-power), arc 806, as compared with 60,632 and 385 respectively. There were also 47 motors at work, representing 54½ horse-power, being an advance on the previous year of 30 motors, equal to 38½ horse-power. The total length of mains laid was 113 miles 742 yards. The total quantity of current accounted for was 1,801,429 units, or 93·49 per cent. of the quantity produced. As will be seen from the accounts, the financial results of the year have been good. The net profit, after defraying all charges for cost of production, &c., provision for renewals, sinking fund, and interest on loans, amounts to £11,138 10s.

REVENUE ACCOUNT (ABSTRACTS 3 AND 4).

	£	s.	d.
The amount derived from sales of current, which works out to 4·97d. per unit accounted for, was ...	37,369	4	4
The meter rents received amount to	883	8	3
Making a total income of	£38,252	12	7
The expenditure was	14,211	5	2
To which is added amount transferred to renewals account	3,491	14	9
	17,702	19	11
Showing a gross profit of	£20,549	12	8
Out of this sum the following requirements had to be met:—			
Interest on mortgage debt, &c. ...	5,149	4	6
Sinking fund	4,261	18	2
	9,411	2	8
Leaving a surplus or net profit, for the year, of...	£11,138	10	0

"This surplus, together with the balance of £5,499 8s. 8d. brought from last year's account, making a total of £16,637 18s. 8d. has been appropriated as follows:—

	£	s.	d.
Paid to city fund in aid of rates	6,963	14	9
Placed to contingent fund	8,521	3	11
Carried to next year's account...	1,153	0	0
	£16,637	18	8

"The financial position of the undertaking at March 31st, 1896, is as follows:—

	£	s.	d.
Total capital expenditure	251,689	12	9
Amount of capital redeemed to date by action of sinking fund	9,186	4	0
Balance at credit of renewals account...	7,491	14	9
" " contingent fund	8,521	3	11
" " net revenue account	1,153	0	0
	£17,165	18	8

"The following additions have been made to the plant at the works, Dickinson Street, during the year, viz.:—Five Lancashire boilers, with mechanical stokers; six compound condensing engines (five vertical and one horizontal) of 400 I.H.P. each; six dynamos, each of 240 unit capacity. The extension to the boiler house is finished, also the new economiser house and feed-water tank, together with the two new economisers. The battery station, Hunt's Bank, is completed, and is now ready to be charged; two new transformer substations have been completed, one at Ardwick Green, the other at All Saints, and the transformers have been fixed in the latter station."

The following table gives the cost per unit:—

	1894.	1895.	1896.
Total capital invested ...	—	—	£251,690
Number of units sold	—	—	1,748,244
Number of lamps connected ...	—	—	89,294 806 arcs and 47 motors
Revenue from sale of current...	—	—	£37,369
Net revenue	—	—	£20,549
Average price obtained per unit	—	—	5·1d.

Cost of Production.	£	s.	d.	Per unit.
Coal	3,049	0	0	·42d.
Oil, waste, water, and engine room stores	1,109	0	0	·15d.
Salaries and wages at generating station	2,795	0	0	·38d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,946	0	0	·27d. (Works' cost 1·22d.)
Rates and taxes	1,584	0	0	·22d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	2,668	0	0	·36d.
Depreciation of buildings and plant account	—			—
Renewal fund account	—			—
Total	£13,151	0	6	1·80d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	37,369	0	0	5·1d.
Meter rents	883	0	0	—
Sale of Lamps	—			—
Total	£38,252	0	0	5·1d.

Total cost per unit (exclusive of depreciation and renewal accounts), 1·80d.; works' cost, 1·22d.

The British Aluminium Company, Limited.

THE directors, in their report, state that the several factories of the company are so far completed that the production of aluminium by the cheapest known processes, and from entirely British raw material is now in successful operation. The acquisition of the necessary elements for the cheap production of this metal has been effected on favourable terms. Since the formation of the company the following works have been carried out:—(*a*) Bauxite mines at Glenravel (co. Antrim) have been opened out and arrangements made that will assure an unlimited supply. (*b*) A large chemical factory has been built at Larne (the nearest harbour to the mines) and equipped with apparatus and machinery equal to the production of several thousand tons of alumina per annum under Dr. Bayer's process, the patents for which are owned by the company. This factory is now in successful operation, and the alumina made is used at the Foyers factory. (*c*) The patent rights acquired by the company to protect the production of aluminium, also cover the production of carbide of calcium, and the company has granted to the Acetylene Illuminating Company, Limited, a license to manufacture this product. The directors expect that, at an early date, considerable profit will be derived from this source. (*d*) The freehold estate of Foyers, on Loch Ness, containing suitable water power, has been bought, together with the water rights of adjacent properties. The necessary engineering works have been carried out, comprising a long tunnel through the rock, lines of pipes, buildings, turbines, dynamos, furnaces, &c., and the factory is now in operation. (*e*) The Milton factory, acquired from the Cowles Syndicate Company, Limited, has been greatly improved and enlarged, by the erection of new buildings, a complete new rolling plant, other machinery, and additional furnaces. This factory has been in full and profitable work for some months. The directors, having found that aluminium manufactured according to certain of the company's patents, has been imported into this country, are taking steps to stop further importation of the metal.

Mr. R. W. Wallace, Q.C., presided at the first ordinary general meeting of the company, held at the Westminster Palace Hotel yesterday. In his opening remarks, the chairman said the title of their company had been confused with that of the Aluminium Company—an exceedingly prosperous company, but not a manufacturing one. Theirs was the only company in Great Britain making aluminium; the only other places in the world where it was made being Neuhausen, in Switzerland, in France, and at Niagara. With the first of these two companies they were in friendly relations, and they had agreed not to import aluminium into Great Britain. They were not in friendly relationship with one of the others; indeed, an action was pending at the present time. The development in the manufacture of aluminium had been remarkable; the price during the past few years had been reduced from 60s. per pound to 1s. 4d., at which it stood now. They had effected a strong combination with other interests, and they controlled the production of raw material. The chairman then went on to speak of the production of aluminium, and detailed the various processes. He then described the various works of the company. They owned very extensive water rights, and their works were able to double the present output. They had not spoilt the Falls of Foyer as had been expected, for water still came over. If they had to fight the American Company on the question of importing aluminium into this country, they would be able, in the ordinary course of commerce, to beat them; but their patents covered a great deal of ground, and the directors believe they were secure on those grounds. He referred to the excellent prospects of the company, based on the large profits made by the Neuhausen Company. He then proposed the adoption of the report, and Lord KELVIN seconded, the motion being carried unanimously.

Some excellent specimens of the company's manufactures were on exhibition at the meeting.

Consolidated Telephone Construction and Manufacturing Company.

THE fifteenth annual general meeting of the above company was held at Winchester House, Old Broad Street, on Thursday, July 9th. Mr. C. L. W. FitzGerald (chairman) presided, and in moving the adoption of the report, said he could not disguise from them that that year their profit on trading had really reached its lowest limit. That was caused by three things. The first and most important of all was the decrease in the sale value. Year after year he had told them that their wages kept up, but the sale value of the goods they sold kept on decreasing. That was caused by the very severe competition there was in the telephone world. They had five other very keen competitors, and there was no doubt that the moment their competitors knew what they sold a telephone at, they undersold them. The other principal cause of the decrease was the fact of their having moved the factory, which, for three months, left them in a disorganised state, and it was with very great difficulty that they were able to execute their orders. He was thankful to say that that was now all over. They had been most fortunate, indeed, in getting a splendid factory on advantageous terms at Coventry. They had paid for it, and it was freehold, and they looked to see considerable saving in rent. In addition they expected to save in rates and taxes; they would use a gas engine instead of steam coal, and they would get their water extremely cheaply. It was thought that in Coventry they would get labour very much cheaper than in London; but at present there was such a demand for bicycle work, that wages had risen. They had also got a building at a very cheap rate at Shaftesbury Avenue. The total receipts on revenue account amounted to £6,614 6s. 6d.; of that amount, £3,209 was received as damages from the Edison-

Gower-Bell Telephone Company. Last year he told them that they had just won a certain action, and they had been told to send in their claim for damages, and their solicitor in Belgium spoke of their receiving a very large sum. The judge, however, who assessed the damages, assessed them at a very small rate—he thought erroneously. That patent action had been fought in England by the National Telephone Company, and it had been upheld that all telephones were covered by the existing Edison patent, and that was the patent they held. The judge in Belgium held otherwise. The result was, that instead of receiving a very large sum of money, they received a very small sum, and then they had to go on with other actions, and try and extract damages from other companies. Two of these companies had now offered to give them certain damages which, together with the law costs, would amount to about £13,000. The money was paid to the Edison-Gower-Bell Company, and of that sum their company received about £10,400. In the balance-sheet they had the very small trading profit of £127; dividends, £3,233 6s. 2d.; the profit on law suit, £3,209 0s. 11d.; and two other little items, making a total of £6,614 6s. 6d. On the debit side their expenses amounted to £1,771, a decrease of £250, caused by the reduction of the directors' fees. They carried a balance down of £4,622 9s. 7d., and with the balance brought forward and incoming dividends, they made up a total of £5,870 5s. 6d. On the other side, they had made good provision in the way of writing off, and they were left with a balance of £3,023 9s. out of which they proposed a dividend of 1½ per cent., and to carry forward £1,393 10s., which was about £150 more than last year. They intended to force the actions to get as much damages as possible. It was difficult to say anything as to the future of the manufacturing business, but if they went on as they had been going lately, the balance-sheet would look very different next year. Their subsidiary company—the Anglo-Portuguese Telephone Company—was going on very steadily, and but for the high rate of exchange would do exceedingly well.

Sir A. ARMSTRONG seconded the motion, which was carried after some discussion.

National Telephone Company.

THE directors have resolved, subject to final audit, to recommend at the forthcoming general meeting the following dividends for the half-year ending June 30th last:—At the rate of 6 per cent. per annum, less income-tax, on the amounts paid up on the 1st and 2nd preference shares; at the rate of 5 per cent. per annum, less income-tax, on the amounts paid up on the 3rd preference shares; at the rate of 5 per cent. per annum, free of income-tax, on the amounts paid up on the ordinary shares, being the same dividend as was paid in respect to the corresponding half-year of 1895, carrying the same amount to reserve—namely, £35,000—and about £17,000 forward, as against £3,907 last year. The transfer books of the company will be closed from the 17th inst. to the 30th inst., both days inclusive, and the dividend warrants will be posted on the latter date.

The United River Plate Telephone Company, Limited.

THE ordinary general meeting was held on Tuesday at Winchester House, Mr. J. Irving Courtenay presiding. The chairman congratulated the shareholders on the improved condition of their property. The results of the past year's working, to March 31st, were better, and their prospects looked brighter; and the directors therefore recommended a dividend of 4 per cent. on the paid-up share capital, being an increase of 1 per cent. upon the distribution of the previous year. They were all aware how rapidly matters changed in the Argentine Republic. Their past experience of comparatively recent date was not forgotten—how periods full of promise had been suddenly succeeded by gloom and anxious times; and it was therefore all the more gratifying to observe the increasing steadiness and stability of affairs generally in the River Plate, by which the company had profited to an extent which had quite equalled their expectations. The system of accounts had been altered, the receipts and expenses having been taken at the actual sterling value each month instead of at the par of exchange, as heretofore. This was the method employed by most British companies. The gross receipts had been £48,744 as against £36,673 in the previous year; and the working expenses in the River Plate had been £24,967, as against £17,555. To give a first-class service such as the company now afforded it was necessary not only to have the plant in good working order, but that it should be handled by intelligent and skilful operators, who naturally commanded good wages. They considered the extra amount spent in wages, as recommended by their representatives in the River Plate, to be both necessary and beneficial. The number of subscribers continued to augment, there being a total on March 31st of 6,231, or an increase of 433 for the year. Exchange had also been more favourable to them. Their plant generally was in very good order, but a large continuous outlay was necessary, owing to the opening of new streets and the erection of new buildings. Mr. Chappell, their general manager in the River Plate, reported that most of the important alterations and repairs to their outside lines and wayleaves, which were commenced over a year ago, were either finished, or rapidly approaching completion, and they would be of immense benefit to their service. The Provincial Telephone Company, in which their company were largely interested, was steadily progressing. The manager reported that all the staff had worked well. All the indications pointed to the current year's result being still more satisfactory than that of the previous year. He concluded by moving the adoption of the report, and the declaration of the dividend therein recommended.

The MANAGING DIRECTOR (Mr. Frank W. Jones) seconded the motion, which was unanimously carried.

City and South London Railway Company, Limited.—The accounts for the half year ended June 30th show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1⅛ per cent. per annum, carrying forward a balance of £1,072 to the new account. The dividend for the corresponding period last year was at the rate of 1¼ per cent. per annum, the balance carried forward being £965.

The Direct United States Cable Company, Limited.—It has been resolved to recommend a final dividend of 2s. 6d. per share, free of income-tax, such dividend to be payable on and after the 30th inst., making, with the interim dividends already paid, 2½ per cent. for the year ending June 30th last, and after placing £7,500 to reserve fund account, carrying forward a balance of £4,235 11s. 11d. The transfer books of this company will be closed from July 14th to 28th, both days inclusive.

County of London and Brush Provincial Company, Limited.—The directors have declared an interim dividend for the half-year on the first and second issues of preference shares at the rate of 6 per cent. per annum, payable on 21st inst., on the amounts paid up thereon, from the due dates of instalments. The transfer books of the company will be closed from July 14th to 21st, both days inclusive, for the purpose of preparing the dividend warrants.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending June 30th of 12s. per cent. on the ordinary stock, and 24s. per cent. on the preferred stock, less income-tax, payable on August 1st to stockholders registered on the books of the company on July 8th.

The Charing Cross and Strand Electricity Supply Corporation, Limited.—The directors have declared an interim dividend for the half-year ended June 30th, 1896, at the rate of £5 per cent. per annum on the ordinary share capital of the corporation, and carried forward £6,100, after payment of all interest on debentures.

Eastern Extension Telegraph Company, Limited.—The interest on the 4 per cent. mortgage debenture stock for the half-year ending July 31st will be paid by warrant on August 1st next. The 4 per cent. mortgage debenture stock register will be closed from the 28th to the 31st inst., both days inclusive.

The City of London Electric Lighting Company, Limited.—Warrants for the payment of an interim dividend for the half-year ended June 30th, 1896, at the rate of 6 per cent. per annum, on this company's preference shares, have been posted.

Telegraph Construction and Maintenance Company, Limited.—The directors announce the forthcoming payment of an *ad interim* dividend of 12s. per share to all shareholders on the register on 13th inst.

River Plate Electric Light and Traction Company, Limited.—Allotment letters of the issue of £125,000 (part of a total authorised issue of £150,000) five per cent. first debenture stock have been posted.

Notting Hill Electric Lighting Company, Limited.—This company has declared an interim dividend for the six months ending June 30th, at the rate of 6 per cent. per annum, payable forthwith.

Eastern Telegraph Company, Limited.—The board announces a dividend of 3s. per share on the preference, and 2s. 6d. per share, with a bonus of 3s. per share, on the ordinary shares.

The Marquis of Tweeddale has been elected chairman in place of the late Sir John Pender.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 12th, 1896, were £937; week ending July 14th, 1895, £848; increase, £89; total receipts for half-year, 1896, £1,818; corresponding period, 1895, £1,763; increase, £55.

The Liverpool Overhead Railway Company. The receipts for the week ending July 12th, 1896, amounted to £1,252; corresponding week last year, £1,186; increase, £66.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 10th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, were £2,889.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, July 8th.	Closing Quotation, July 15th.	Business done during week ended July 15th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104 xd	100 —104	101⅜	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	9 — 10	9 — 10	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	49 — 51	50 — 52 xd	50	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	92½ — 93½	93½ — 94¼xd	94⅛	93½
2,993,560£	Do. do. Defd.	Stock	...	...	...	9 — 9⅛	9 — 9⅛	9 5/16	9
130,000	Brasilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	15 — 15½	15 — 15⅝	15 7/16	15
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	5 %	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	...	3½ — 3⅝	3½ — 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	1½%	1/16 — 1/8	1/16 — 1/8	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12½ — 13½	...	...
5,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19½ — 20½	20 — 21	20⅜	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	106 —109 %	106 —109%	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	2¼%	9⅜ — 10¼	9⅜ — 10¼	9⅜	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6¼%	6¼%	17 — 17½	17⅛ — 17⅜	17⅜	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	6	18½ — 19	18⅜ — 19	...	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	106 —109	106 —109	108½	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	131 —134	131 —134	131½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17½ — 18	17½ — 18	18	17½
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	132 —135	132 —135	133	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114 %	111 —114 %	112	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅜% §	4⅜%	4⅜%	10¼ — 11	11 — 11⅛	11⅛	10 13/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	6 %	17½ — 17⅞	17⅛ — 18	17⅞	17⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	8⅝%	10 %	23 — 24	23½ — 24½	...	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	52 — 55	53 — 56	54½	54⅛
100,000£	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	111 —114	111 —114	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5⅛%	7⅝ — 7⅞	7⅝ — 7⅞	7 13/16	7 9/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16½ — 17½	16 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅜ — 7	6⅞ — 7⅛	7⅛	6 15/16
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —108	105 —108	108	105½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	5 %	⅜ — ⅞	⅜ — ⅞	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	106 —109	106 — 109	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	5 %	6¼ — 7½	7 — 8	7 7/16	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	...	3¾ — 4½	3⅝ — 4¼xd	4 3/16	4
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	4 %	7 — 8	7 — 8	7½	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 —106	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	*nil*	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	93 — 103	93 —103	...	...
64,248	Western and Brasilian Teleg., Ltd.	15	2½%	3 %	3 %	8¾ — 9¼	8⅝ — 9¼	9¼	8⅝
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6⅝ — 7¼	6⅝ — 7¼	7⅛	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	2¼ — 2⅝	2¼ — 2⅝	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	105 —109	105 —109	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	105 —109	105 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	⅛%	1⅛ — 1⅜	1⅛ — 1⅜	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11½ — 11¾	11½ — 11¾	11¾	11 5/16
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9¼ — 10½	9¼ — 10¼	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —105	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	8¼ — 8⅜	8¼ — 8⅜	8⅜	8 7/16
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7½ — 8	7⅞ — 8¼	7⅞	7½
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4 %	114 —116	114 —116 xd	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14½ — 15½	14½ — 15½	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16¾ — 17½	16⅝ — 17½	...	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —137	133 —137	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	*nil*	8½ — 9½	8¼ — 9½	...	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	6 %	13½ — 13⅝	13 — 13½xd	13 7/16	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	13 — 14	12½ — 13½	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	119 —121	119 —121 xd	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	10 — 10½	10 — 10½	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	11⅝ — 12½	11½ — 12⅜	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9¼ — 10½	9½ — 10½	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	...	104 —106	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	10¼ — 10⅝	10½ — 11	10⅝	10⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation July 8th.	Closing Quotation, July 15th.	Business done during week ended July 15th, 1896. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	5 %	2½%	...	1⅛— 1⅜	1⅛— 1⅜	1⅛	1 1/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	3 %	...	1½— 1⅝	1⅜— 1⅝	1⅜	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000£	City and South London Railway	Stock	1 1/16%	1 1/16%	1 5/16%	43 — 45	44 — 46	45	44½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 %	*nil*	...	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	...	1½— 2	1⅝— 2¼	2	1 9/16
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	103 —105	103 —106	103	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	1½— 1½	1½— 1½	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2½— 3	2½— 3	2⅝	...
91,195	Elmore's Patent Cop. Depoag., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅜— ⅞	⅜— ⅞	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅜— ⅝	⅜— ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	...	10½— 11½	10½— 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	17 — 18	17½— 18½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	17 — 18	17 — 18	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	21 — 23	21 — 23	22½	22
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅝%	14 — 14½	13⅞ — 14	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	17⅛ — 17⅝	17⅛— 17⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	38 — 41	37 — 40	40	39
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105xd	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	8 — 8½	8 — 8½	8	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0%; 1894—7½%; 1895—5%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 103—105.

House-to-House Company (£5 paid), 4—4¼.

Do. do. 7 % Preference, of £5, 8¼—8⅜.

Do. do. 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 9¼—9⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7½—8.

London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7½—7⅝.

Bank rate of discount 2 per cent. (February 22nd, 1894).

REVIEWS.

Submarine Cable Laying and Repairing. By H. D. Wilkinson, M.I.E.E. The *Electrician* Printing and Publishing Company, Limited, Salisbury Court, Fleet Street, E.C.

(*Continued from page* 42.)

The design of a core required for a given speed with a given length of cable is dealt with in a clear and original manner, but the author's disquisition on the advantage of having the insulation of the dielectric not below or above certain values, seems to show a lack of experience, seeing that it is practically impossible to place a maximum limit upon the insulation resistance of a completed cable. No mention, we observe, is made of the useful tables compiled by Mr. A. Dearlove.

Dealing with the sheathing of cables, Mr. Wilkinson gives some useful information. Surely he is wrong in saying that the angle of lay, or the angle that the direction of the spiral makes with the cable, is approximately the same for all sizes, and consequently the lay varies directly as the circumference of the pitch circle. Working on this, and taking the lay in a deep-sea type as 10 inches, which is the usual one, he gets the lay for a shore end as 30 inches. This is about double as much as it should be. The various steps in the manufacture are clearly explained, and on page 306 are two illustrations showing the different layers of material in a completed cable. One of them (fig. 164), is scarcely correct, as the coat of compound outside all is, if anything, thicker than the layer of yarns.

Capital illustrations are given of a core-serving machine, and of closing machines for shore end and deep-sea types. The latter, it is stated, works at 60 revs. per minute, and will cover four or five miles per day of 10 hours. This would be good work. Running at the same speed, we believe, one of Messrs. Henley's machines has done nine miles in the 24 hours, and the machines of the Telegraph Construction and Maintenance Company, each having its own engine and running at 100 revs. per minute, have covered six miles in 12 hours.

Some interesting remarks occur on page 305 with regard to the direction of the lay of cables, and the reason is given for the adoption of the left-handed lay.

For more information about types of cable, we have to hark back to page 48. Here we find described the seven leading types of cable as manufactured by the Telegraph Construction and Maintenance Company, and on page 49 they are shown in section. Some explanation should have been given as to why the sheathing wires are not shown butting firmly against one another. The student would be apt to think that the spaces between are left purposely; whereas, in fact, the wires are laid up as tightly as possible, but owing to their never being perfectly straight and regular, they seldom all butt firmly together at any one spot. Some manufacturers, however, like the coat of jute over the core to be so full that the wires never actually touch one another. In practice it is usual in a 12-wire cable to add 5 per cent. to the theoretical external diameter.

The introduction of brass taping as a protection against the teredo is erroneously attributed to Mr. Henry Clifford instead of to Sir Charles Bright. Mr. Clifford was the first to apply the brass tape directly over the core, and patented a method of applying the brass and cotton tape at one operation. Of late years, curiously enough, there has been a tendency, especially in the case of multiple-cored cables, to revert to Bright's original system, and apply the tape over the jute bedding surrounding the cores. The type of cable for very deep water having alternate wires and yarns is one which will never again be used, it is quite certain, and we cannot understand how Mr. Wilkinson came to describe it. It is just one of those cases which are only useful as a warning to others. The most popular type of cable for deep water just now is one having each of the wires taped with a prepared cotton tape, after having been passed through a compound containing more or less (generally less) of India-rubber; but

as to whether this type is worth its cost we should be sorry to express an opinion. Of the two new Atlantics laid last year, one was the ordinary close sheathed, and the other the taped wire type. It is amusing to be told that the compound applied to the outside of a cable is a mixture of gutta-percha and Chatterton's compound (one part each of Stockholm tar and resin, and three parts of gutta percha). *Credat Judæus!*——

The shipping of the completed cable is dealt with on page 308, *et seq.*, and the wonderful speed of 68 miles shipped in 12 hours is mentioned. This was done on board the *Silvertown*, when loading the South American cable, and the actual time was only 11½ hours, we believe. Previous to this the record was 65 miles shipped during 11⅔ hours in 1887.

We now come to the landing of shore ends (page 316), and find the various methods not only described but nicely illustrated. The first one, fig. 171, is that usually employed by the Silvertown Company. It is a most valuable one on coasts where there is a surf, or where a convenient lighter is not to be had. Under ordinary circumstances, the method illustrated on page 325 is preferable from every point of view. Fig. 174 is not a good illustration of the way a lighter is fitted up for laying a shore end. It is not often necessary to make any platform whatever for the cable, and the friction table bell mouth and paying-out sheave are made all on the same balk of timber, and are thus far more easily shipped and lashed down in position.

We now jump to page 352, and, before starting laying our cable, turn our attention to the cable house or hut, and the landline connecting it with the office. Very wisely, Mr. Wilkinson briefly describes the cable house as a small building of iron or wood. Most electricians are far too sick of them to want to read any further description. However, we have seen huts which have been most carefully planned, so as to secure the maximum comfort consistent with portability, and there have been most elaborate arrangements to protect the hut, and possibly its occupants, against the ravages of insects; ant-proof pillars for the hut, as well as ant-proof galvanometer stand and tube for the cable ends.

The question of how to protect the cable between the beach and the hut scarcely receives enough attention. There is not part of a line more likely to give trouble than this. Enclosing the core in brass tape or lead tubing is an excellent plan, because both of these coverings are practically air-tight; but the best way of all is to make the trench so deep that even at low tide water flows right along it. A little brushwood placed on the top of the cable before filling in facilitates this. Under the hut a couple of fathoms or so of spare cable should be coiled at the bottom of the trench, and from this point the cable should be taken vertically up into the hut itself through an iron pipe. The bottom end of this pipe should be in water, and its top should be provided with a gland, through which the core only passes. Paraffin wax then being run in, a perfectly air-tight joint is made, and the projecting end of core being also coated with the wax and the conductor properly fixed to an insulated terminal, it need never be touched, and should never give trouble. The middle of the hut is the best place for the end to come up, but at all events it should be kept clear away from the walls. Only last year communication with South Africa was completely interrupted through a fire being lighted over a buried shore end, and the owners of the cable seemed to be rather proud of the fact that the interruption was caused by such a simple thing, instead of being heartily ashamed of their negligence. Its the old story of the things which are the easiest to do often being done the worst. The end of a cable is hurried ashore, a hasty trench is dug, and away the ship goes.

Between the hut and the office, if the ground permits of a deep trench being dug, a core, covered with either brass tape or a leaden tube, will be found perfectly satisfactory; but in many cases the ground may be rocky, and then the system of pipe lines which Mr. Wilkinson describes, and which we believe were first introduced by the Eastern Telegraph Company, are necessary.

In addition to the lightning guards described, mention should certainly have been made of the Siemens plate protector.

(To be continued.)

ALTERNATE CURRENT TRANSFORMERS.

By Dr. J. A. FLEMING, F.R.S.

Society of Arts Cantor Lectures. Lecture I., delivered January 20th, 1896.

The Action of the Transformer.

In the last ten years the alternate current transformer has been developed from an experimental instrument into a practical appliance of immense utility. According to recent statistics, there are at present about 50 alternating current electric supply stations in the United Kingdom, supplying not less than 1,100,000 8-candle-power lamps. This amount of lighting requires the expenditure of 54,000 horse-power, or 40,800 kilowatts at full load, and hence there must be transformer capacity in the United Kingdom at the very least equal to 40,000 kilowatts. These transformers, as presently to be explained, all contain an iron core, which has to be magnetised and demagnetised 200 times a second, or 6,000,000 times a year. The total weight of iron cores in the whole of these transformers will be certainly not less than 400 tons, and it will require at least 400 kilowatts to maintain the magnetisation of these cores. If these transformers are connected with the circuits only, on the average, 4,000 hours a year, it is very easy to see that the magnetisation of the cores of the transformer will require not less than 1,600,000 Board of Trade units spent per annum in magnetism, and this means at least 16,000,000 lbs. of coal, or 8,000 tons. Hence, in the United Kingdom, we have buried away somewhere or other at least 400 tons of iron forming the cores of transformers, and these involve at least an expenditure of 8,000 tons of coal, costing some £6,000 sterling to maintain that magnetisation. It is, therefore, easily seen that the study of the construction of the alternate current transformer, and its possible improvement, is one which is not at all unimportant, from an engineering point of view.

I propose to assume in these lectures that the majority of those present are acquainted with the principal facts connected with the flow of alternating currents of electricity in inductive circuits, and to address myself more particularly to the study of alternating current transformers from a practical point of view, discussing in the four lectures of this course the action of the transformer, the construction of the transformer, the testing of the transformer, and the employment of the transformer. You are all probably aware that an alternating current transformer in its simplest form consists of two circuits of insulated wire which are wound upon an iron core, and that this device operates to transform electric energy in such fashion that the flow of an alternating current through one circuit is made to produce another current in the second circuit, with an increase or decrease of current strength taking place at the expense of potentials. The transformer does no more than any lever, wheel and axle, or simple machine in transforming power from one form into another form. The general operation of the transformer or induction coil, in whatever form it may be taken, is then as follows:—Through one of the circuits, called the primary circuit, is passed an intermittent, interrupted, or alternating current. This primary circuit is interlinked with a magnetic circuit, and the primary circuit establishes in the magnetic circuit an intermittent, interrupted, or alternating induction; the magnetic circuit is interlinked with a secondary circuit, and the variation of magnetic induction in the core creates an electromotive force in the secondary circuit, which at any instant depends upon the rate of change of the total induction linked with the secondary circuit.

As the word "induction" will very frequently be mentioned during the succeeding lectures, it is exceedingly important there should be no ambiguity in your minds as to the meaning of this term. We may help ourselves by regarding the analogy of conducting circuits and magnetic circuits. Consider a conducting circuit in which an electric current exists. As long as the circuit is closed we recognise the presence of the current, either by heat produced in the conductor, or by electrolysis, and by various magnetic and dynamical actions in the medium round it. We select some one of these effects, say the electrolytic effect, and we base our quantative definition of current strength upon it; thus, for instance, the accepted definition of an ampere is that it is a current which in one hour deposits, electrolytically, 4·025 grammes of silver. The cause, whatever its nature, producing the current is called the electromotive force. If we draw any line linked with or surrounding the conductor conveying the current, whether that line be included in a magnetic material like iron, or a non-magnetic material like air, we find a physical action taking place in that path which is called magnetic induction, and the immediate cause of this magnetic induction we speak of as magnetic force. We measure this induction by one of the effects it can produce, namely by the electromotive force which it can set up in another conducting circuit linked with the magnetic circuit when that induction is suppressed or reversed at a given rate. Faraday showed that the proper measure of the total magnetic induction linked with any conducting circuit was the total quantity of electricity set flowing in the circuit when the magnetic induction is suppressed or reversed. In practical work it is better to abandon the rather academic phrase, "number of lines of force" or induction, so much used, and to think of the induction as a physical effect produced in the magnetic circuit, its value being reckoned in *webers*, the induction being produced in the magnetic circuit by magnetic force, just as electric current reckoned in amperes is produced in the conducting circuit by electromotive force. Hence we have this definition of a unit of magnetic induction. A unit of magnetic induction, called one weber, is an amount of induction which, when linked or unlinked with a circuit of one turn, and having a resistance of one ohm, causes one coulomb of electric quantity to flow round the conducting circuit. Generally speaking, if induction is measured in webers (1 weber = 10^8 C.G.S. units), we have the following relation between the magnetic induction, the number of

turns or linkages which the secondary circuit makes round the line of the induction, the resistance in ohms of the secondary circuit, and the total quantity set flowing in the secondary circuit reckoned in coulombs.

Webers × linkages = coulombs × ohms.

Since one weber is a larger amount of induction than is met in any single transformer core or dynamo magnet, it is convenient to take the millionth part of this as the practical unit, viz., the *microweber*, and to commit to memory the following rule: Microwebers × linkages = microcoulombs × ohms, and to recollect that one microweber is equal to 100 C.G.S. units of induction, or what would commonly be called 100 lines of force. In order to measure induction, we require then a ballistic galvanometer as a practical instrument to measure electric quantity; and we can at once make a measurement of the induction in any magnetic circuit by determining the quantity of electricity set flowing in a circuit of a known number of turns which is linked with this induction, and then unlinked, by withdrawing the circuit or reversing the induction. As a practical illustration of these methods, it will be useful to make a measurement of the induction existing in this closed iron ring, when it is magnetised by a current flowing round it. The ring, as you see, is wound over closely with one layer of wire, which we will call the primary circuit. If we measure the mean perimeter of the ring, and count the number of turns, it is a simple matter to obtain the number of turns per centimetre. If a current, measured in amperes, is set flowing through this circuit, then it can easily be shown that the magnetising force acting upon the iron is equal to $1\frac{1}{4}$ times the turns of wire per centimetre, multiplied by the ampere current flowing through the circuit.* This magnetising force produces in the iron a certain magnetic induction which is measurable in microwebers. In order to find out the magnitude of this induction, we put upon the ring a secondary circuit of a known number of turns. We then employ a ballistic galvanometer suitable for measuring electric quantity, and we must first calibrate this ballistic galvanometer to determine the excursion or throw of the needle, when a given quantity of electricity measured in microcoulombs is sent through it. This is most easily done by charging a condenser of half a microcoulomb by means of a standard cell having an electromotive force of 1·5 volts, and discharging this quantity of 1·5 × ·5 = $\frac{3}{4}$ microcoulomb through the galvanometer. This produces a certain throw or excursion of the needle, and we may then assume that for any other throw of the needle the quantity of electricity producing it is proportional to the throw as determined by the above calibration. In order to measure the magnetic induction in the iron circuit, all that we have to do then is to connect the secondary circuit having a known number of turns, and the resistance of which, added to that of the galvanometer and connecting wires must be determined in ohms, and observe the throw of the galvanometer needle, which is produced when the primary current is reversed. Ascertaining from the previous calibration the electric quantity measured in microcoulombs represented by this throw, we multiply that number by the total resistance of the secondary circuit, including the galvanometer measured in ohms, and divide the product by the number of linkages or turns of the secondary circuit. This quotient gives us double the induction measured in microwebers existing in the iron core at the time when the steady current is flowing through the primary circuit, hence the induction is at once measured in microwebers.

Returning then to the alternate current transformer, we may classify transformers, converters, or induction coils as they are also called, according to their construction, and their use as follows: Transformers may be (*a*) iron-core transformers, with a core wholly or partly of iron; (*b*) air-core transformers with a core or magnetic circuit wholly of non-magnetic substance. Iron core transformers may be (*c*) closed iron circuit transformers with a magnetic circuit wholly of iron (*d*) open iron circuit transformers with a core partly of iron. Transformers may be used (*e*) to transform a potential difference in a constant ratio, in which case they are called constant ratio transformers; (*f*) to transform a current strength in a constant ratio, in which case they may be called constant transformers. The transformers may be employed (*g*) to raise pressure or current, and they are then called "step up" transformers; (*h*) to lower pressure or current, and then they are called "step down" transformers. This is not an exhaustive classification, but it is sufficient for practical purposes. By far the most important member of the group is the constant potential closed iron circuit transformer employed with alternating currents taken from a constant potential primary circuit. This may be considered from its importance to be the chief of the clan, and to it, therefore, we shall pay most attention. In order to possess a complete knowledge of the operations and action of such a transformer, we require to know the nature of the operations going on in all parts of it at the same instant. We have seen that the broad general action of the transformer as employed with alternating currents is as follows: If an alternating primary current is passed through the primary circuit it acts upon the iron core with an alternating magnetic force, and creates in the iron core an alternating magnetic induction. If a secondary circuit is also wound round the same iron core, the periodic variation of magnetic induction in the magnetic circuit creates a periodic electromotive force in the secondary circuit, and if that circuit is closed, creates in it a periodic secondary current. The method which of late years has proved most fertile in adding to our real knowledge of the subject of the transformer is that of delineating graphically the various periodic quantities concerned, by a process which is called alternating current curve tracing. It is, therefore, necessary to study this process in some detail. Suppose that we have an alternating current dynamo or alternator in operation, we know that the potential difference between the terminals of this machine undergoes periodic variation, and that it passes from one maximum in one direction to another maximum in an opposite direction. At any instant the machine is producing an electromotive force which is called its instantaneous value. Suppose that the alternator terminals are connected to a condenser, the potential difference of these condenser plates follows the same law of variation as the electromotive force of the machine. If the condenser is removed at any instant, and the potential difference of its plates examined that will give us the potential difference of the terminals of the alternator, or the electromotive force of the alternator, at the instant when the condenser was disconnected. The practical arrangements made for doing this, which I have found it convenient to use, are as follows: A small alternating current motor (see fig. 1) has its field magnets excited by a constant

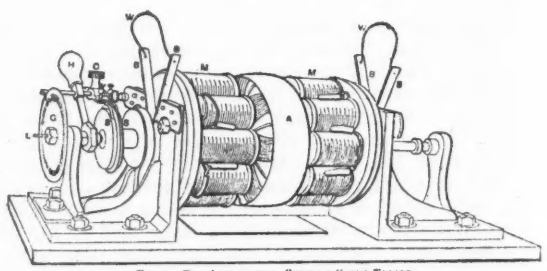


Fig. 1.—The Alternating Current Curve Tracer.

continuous current, and its armature traversed by a current coming from the alternator under examination. The shaft of this alternating current motor carries an ebonite disc, on which is placed a small steel slip. As the disc rotates, the steel slip passes at each revolution underneath two small steel springs, lightly touching the ebonite disc. The steel slip, therefore, electrically connects these springs (which are otherwise insulated) together, and this connection takes place at each revolution. The two springs are carried on an insulated bar, which is capable of being moved round an arc of a circle in such a manner that the instant when the springs are connected together can be altered and determined by the angular position of the rocking bar, carrying the two springs as read off on a scale. If this little alternating current motor is started in step with the alternating current machine it will keep in step with it, and will close the circuit of the two springs once during every revolution at an instant during the complete phase of the electromotive force depending on the position of the springs. These two springs, constituting the revolving contact breaker, are connected in series with a small battery of lithanode cells, B (see fig. 2), and these again with an electrostatic

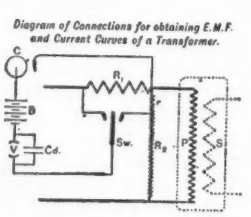


Fig. 2.

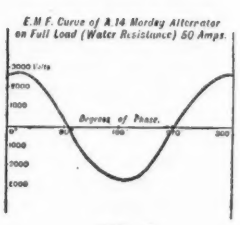


Fig. 3.

voltmeter, V, across the terminals of which a condenser, C *d*, is joined. This appliance may then be employed to determine the form of the curve of an alternating current, or an electromotive force, as follows:—Suppose it be desired to determine the curve of electromotive force of any alternator, the contact breaker is joined across the terminals of the alternator, and the reading of the voltmeter is taken as the rocking arm carrying the springs is moved round by steps through an angular interval corresponding to one complete period. At equal intervals during the movement, the electrostatic voltmeter is read, and in order to bring the readings within the best part of the scale of the voltmeter, a selected number of the cells of the battery, B, are placed in series with the voltmeter so as to add a known electromotive force to the electromotive force being measured.* By the employment of a revolving contact breaker of this form, a number of curves were taken from the alternating current machines in the City of London Electric Lighting Station at Bankside, some of which are shown in the accompanying figures.

Fig. 3 represents the electromotive force curve of a Mordey alternator on full load, the load being a water resistance. It will be seen that the curve of electromotive force is not very far from a simple periodic or simple sine curve, as shown in fig. 4. Fig. 5 shows the electromotive force curve of a larger Mordey alternator at no load, and fig. 6 shows the manner in which the electromotive force curve, at no load, is related to the position of the pole-piece represented by

* *Vide*, "The Alternate Current Transformer," Fleming. New Edition. Vol. i., p. 23. The *Electrician* Printing and Publishing Company, 7, Salisbury Court, Fleet Street, E.C.

* For further details see the "Alternate Current Transformer." Fleming, Vol. i. (new edition), p. 521.

the rectangular line. The electromotive force curve of an alternator is, however, not by any means always so nearly a simple periodic curve. Fig. 7 represents the electromotive curve of a Thomson-Houston alternator taken at no load. The position of the field poles with respect to the electromotive curve being shown by the square rectangles in the figure. Fig. 8 shows the electromotive force curve of the same

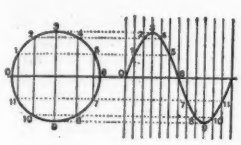


FIG. 4.

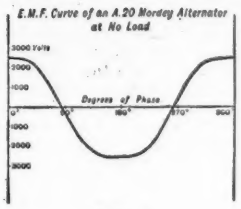


FIG. 5.

machine when working on a highly-inductive load of transformers. In order to determine the form and relative position of the current curve, all that it is necessary to do is to put in series with the alternator circuit a non-inductive resistance sufficient to carry without sensible heating the outgoing current. By connecting the revolving contact breaker and associated voltmeter with the terminals of this

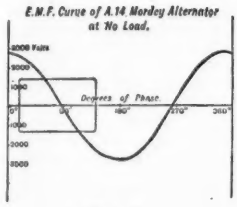


FIG. 6.

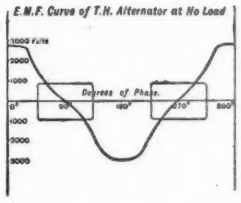


FIG. 7.

non-inductive resistance, we can delineate the curve of fall of potential down the non-inductive resistance, which is identically the same thing as the curve of current in the resistance.

In this manner have been determined the current curves taken from the above-mentioned machines, both on inductive and non-inductive

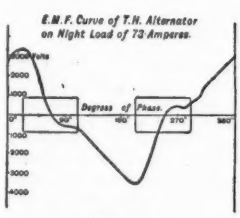


FIG. 8.

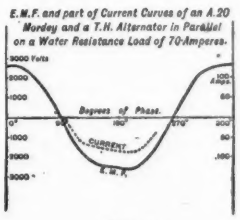


FIG. 9.

loads. Fig. 9 shows the electromotive force curve and part of the current curve of a Mordey and Thomson-Houston alternator on a water resistance; and fig. 10 shows the current curve and part of the electromotive force curve of a Thomson-Houston alternator, working on a water resistance. These diagrams show that when an alternator,

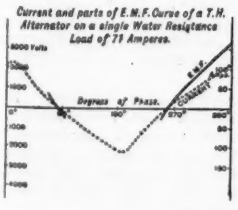


FIG. 10.

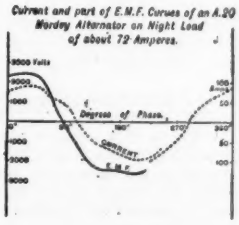


FIG. 11.

having an electromotive force of 2,000 volts, is working on a water resistance, this load is an absolutely non-inductive load, the current curve being practically perfectly in step with the electromotive force.

This leads to the conclusion that in testing a high tension alternator for efficiency, it is quite sufficient to load up the machine on water resistance to measure the current going out of the machine as ordinarily measured on an alternating current ammeter, to measure the difference of potentials at the terminals of the machine, as measured on an alternating current voltmeter, and to multiply the values of the two readings together, and thus obtain the true power in watts being given out by the machine on the water load. There is no question of difference of phase in this case. If, however, the alternator is working upon an inductive load, such as a number of transformers lightly loaded, then the current curve lags behind the electromotive force curve by a definite amount at the zero value. This is shown in curves, figs. 11, 12, and 13, giving respectively the

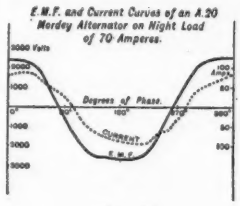


FIG. 12.

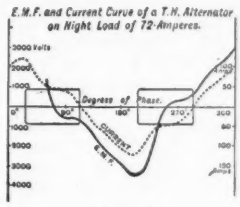


FIG. 13.

electromotive force and current curves of a Mordey alternator, and a Thomson-Houston alternator working on transformers lightly loaded. It will be seen that the difference of phase between the current and electromotive force curves is different at different parts of the curve; in the case of the Thomson-Houston alternator there is no difference of phase between the maximum values of the current and electromotive force, but a considerable difference between the zero values. In the diagram of the Thomson-Houston alternator the position of the field poles is shown by the square rectangles, which, therefore, indicate the manner in which the electromotive force curve is related to the field poles in the machine. It must not be supposed that the form of the current curve, or of the electromotive force curve, is a fixed attribute of the alternator, that is to say, we cannot speak of the electromotive force curve of an alternator as if it were something unchangeable and peculiar to that machine. It often largely

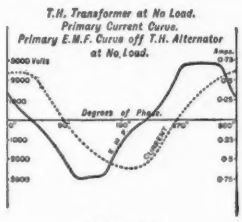


FIG. 14.

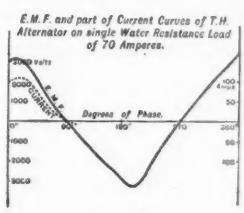


FIG. 15.

depends upon the nature of the load. Thus, for instance, in fig. 14, is shown the form of the electromotive force curve of a Thomson-Houston alternator when very lightly loaded, and in fig. 15 is shown the electromotive force curve of the same machine when loaded on a non-inductive resistance to a fair proportion of its full load; whilst on referring to fig. 13 we see the form of the electromotive force curve of the same machine when working on an inductive load, and it will be noticed how very different in form are those three curves.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

14,317. "Improvements in electric tramways." J. ENRIGHT. Dated June 29th.

14,331. "Improvements in and connected with electric tramways or railways." A. G. ADAMSON. Dated June 29th.

14,332. "Improvements in apparatus for the use of electric light, gas, or oil for photographic, illuminating, and other purposes."

14,367. "An improvement in electro-deposition of metals and metallic alloys." C. A. HALES. Dated June 29th.

14,370. "Improvements in electric arc lamps." A. Klatz. Dated June 29th.

14,376. "Improvements in master clocks for operating or controlling circuits of electrical dials and similar instruments." G. B. Bowell. Dated June 29th.

14,393. "Improvements in anodes for electrolytic purposes." P. Tensen. (H. C. F. Stormei, Norway.) Dated June 29th.

14,397. "Improvements in electric arc lamps." F. V. Andersen. Dated June 29th.

14,462. "Improvements in or relating to systems of electrical distribution." A. J. Boult. (G. J. Scott and W. S. Janney, United States.) Dated June 30th. (*Complete.*)

14,463. "Improvements in telegraphic alphabets." S. Van B. Essick. Dated June 30th. (*Complete.*)

14,464. "Improvements in telegraphy." S. Van B. Essick. Dated June 30th. (*Complete.*)

14,499. "Improvements in microphones." F. Stock. Dated June 30th. (*Complete.*)

14,500. "An improved call counter suitable for telephone exchanges." F. Stock. Dated June 30th. (*Complete.*)

14,551. "Securing so called 'caps' or 'collars' to the necks of incandescent electric lamps." F. Harrison and I. Probert. Dated July 1st.

14,554. "A buoy that can be sunk or raised electrically from a distance." Siemens Bros. & Co., Limited. (Siemens & Halske, Germany.) Dated July 1st.

14,555. "Improvements in the process and apparatus for the papering of iron sheets for electrical and magnetical apparatus." Siemens Bros. & Co., Limited. (Siemens & Halske, Germany.) Dated July 1st.

14,584. "Improvements in or connected with the arrangement and attachments of electrolytic anodes." P. E. Secretan. Dated July 1st.

14,613. "Improvements in telephonic transmitters." A. Marr. Dated July 2nd.

14,639. "Improvements in apparatus for the production of electricity from the waste heat of gas, steam, or other heat engines." H. J. Dowsing. Dated July 2nd.

14,641. "Improvements in electric gas lighters." G. Byng. Dated July 2nd.

14,642. "Improvements in and connected with electric bells, gongs, and the like." M. Byng and F. G. Bell. Dated July 2nd.

14,766. "Improvements in or relating to sockets or holders for incandescent electric lamps and the attachment thereto." E. Worringen. Dated July 3rd.

14,846. "Improvements in conducting contacts with carbon or other non-metallic electrodes." Siemens Bros. & Co., Limited, and Dr. E. Obach. Dated July 4th. (*Complete.*)

14,848. "Improvements in or connected with electric induction coils and transformers." A. Apps. Dated July 4th.

14,872. "Improvements in telephone exchanges." S. Berditschewsky-Apostoloff. Dated July 4th.

14,876. "System of single wire electric transmission based on a method of emitting inverse currents giving absolute control and safety." C. Thuron. Dated July 4th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps.*)]

1895.

6,565. "Improvements connected with the electrolysis of chlorides and other salts, and the evaporation of brine and other solutions." H. Tee. Dated March 30th, 1895. Brine is electrolytically decomposed and salt manufactured therefrom by boiling the brine in covered pans heated by coal, a low pressure or vacuum engine in connection with the pans worked by the steam generated in the pans, such steam condensing maintaining a vacuum, the engine generates electricity and the brine is decomposed by the electricity so produced. 4 claims.

6,565A. "Improvements connected with the electrolysis of chlorides and other salts, and the evaporation of solutions." H. Tee. Dated March 30th, 1895. Brine decomposed and salt obtained therefrom by generating steam in high pressure generators heated by fuel; using such steam in high pressure engines manufacturing salt from brine by exhausting this from the engine at a pressure above that of the atmosphere condensing it at such pressure in salt making pans; generating electricity by said engines, and decomposing brine by the electricity produced. 3 claims.

7,075. "Improvements in and connected with electric cooking and heating grills and similar apparatus." T. Fletcher, W. Russell, and Fletcher, Russell & Co. Dated April 6th, 1895. Consists in manufacturing the bars for cooking and heating grills of a peculiar shape. The upper or front plate is convex in section or so shaped that it slopes down from one edge of the surface to the other so as to obtain a more effective heating surface. Below each lower edge of each bar is arranged a gutter for carrying away the melted fat, &c. 2 claims.

8,453. "Improvements in electrical switches and means of actuating same." J. Brockie. Dated April 23rd, 1895. Relates to an electrical switch for an incandescent lamp circuit combined with a solenoid having its coil in the arc lamp circuit and a core and catch so arranged that when the arc current excites the solenoid, the core being attracted, opens the incandescent lamp circuit and is held by the catch until by cessation or momentary reversal of the arc current the catch is released, when the core again moving closes the incandescent lamp circuit. 3 claims.

9,442. "Improved means for insulating electric conductors." G. G. M. Hardingham. (Felten & Guilleaume.) Dated May 13th, 1895. A method of insulating electric conductors on the air space system consisting in enclosing the several conductors in separate air compartments of a tube of non-conducting material produced from a single strip having its edges folded inwards to form a central wall dividing the compartments and separating the conductors. The tube and enclosed conductors are ultimately twisted about their common axis so that each compartment assumes the form of a spiral passage. Other forms are described and shown. 6 claims.

9,521. "A photographic telegraph recorder." J. Imray. (La Société Industrielle des Telephones.) Dated May 14th, 1895. This consists of a very thin tight wire through which the current passes, situated between the pole-piece of a magnet, so that it is deflected to either side, according to the nature of the electrical impulses passing through it, these being recorded by the shadow of the wire being thrown down on a travelling sensitised strip, or two such wires may carry a screen having a small hole through which a ray of light is projected on the sensitised band. 1 claim.

9,636. "Improvements in electric arc lamps." Siemens Bros. and Co., and Frederick Booker. Dated May 15th, 1895. Relates to the construction of lamps so as to adapt them to be worked in series in considerable numbers. On the base carrying the regulating mechanism is a series magnet having its coil in the lamp circuit, and its armature carried on a lever which, when the lamp is not in circuit, is held back by a spring and a projection upon it presses a pivoted frame, carrying the regulated mechanism into such a position that its escapement is released from a stop and consequently the upper carbon frame descends and the carbons come together. When the lamp is in circuit the electro-magnet attracts its armature, withdraws the projection from the pivoted frame and strikes the arc, and afterwards leaves the frame free to move in obedience to the regulating mechanism. 1 claim.

9,796. "Improvements in conduits for electric cables." W. Hart and J. S. Lucas. Dated May 17th, 1895. Conduits formed of earthenware blocks are provided with inside and outside longitudinal grooves so that if required to connect a branch line, a piece may be broken out. 3 claims.

9,816. "Improvements in electric signalling apparatus for railways." E. Robinson. Dated May 18th, 1895. This apparatus comprises a spring controlled rod, movable in a guide, and projecting through a hole in the rail. Separated contact plates are so arranged that when the rod is depressed it makes contact with the said plates, and completes an electric circuit. 2 claims.

9,966. "Improvements in or relating to arc lamps." A. Lewis Davis. Dated May 20th, 1895. The invention is based on the principle that when a current passes through two coils adjacently disposed, the coils tend to move so that their polar axes coincides. The parts of the apparatus are so arranged as to act as an automatic feed regulator. Two coils are employed, one movable and having fixed to it a driving wheel having an inoperative part on its periphery. This wheel engages another wheel controlling the carbon holders. The inoperative part is so arranged that when the coil it is attached to is at right angles to that of the other coil, that part is presented to the other wheel and is consequently disengaged. A spring is also arranged with the movable coil which tends to keep its polar axis at right angles to the axis of the other coil. 4 claims.

10,277. "Improvements in apparatus for measuring electrical currents." Siemens Bros. & Co., Limited, and E. F. H. H. Lauckert. Dated May 24th, 1895. Relates to that class of instruments in which the one-pole of a magnet mounted on an axis is drawn into the wire coils through which the current to be measured passes. The invention consists in rendering such instruments astatic by placing another magnet parallel to the first, and on the same axis, but having its poles reversed outside the coil. A method is also described for enabling the instrument to afford readings for currents passing either in one direction or the other through the coil. 2 claims.

22,133. "Improvements in telephone message counters." F. W. H. Hempel, M. Gumpel, and A. Maerker. Dated November 20th, 1895. Consists of a counter mechanism arranged near the calling device, and a slide coupled to the counting mechanism. Means are also provided for depressing the slide to operate the counting mechanism by means of the calling device. The slide is raised by hanging the receiver in its place. 3 claims.

24,711. "Improvements in or relating to electric brakes." J. Devonshire. (W. B. Potter, United States.) Dated December 24th, 1895. Combines a number of electric motors arranged in multiple, with equalising connections connecting similar terminals of the field magnet coils at each end of such coils, together with equalising connections connecting similar terminals upon both sides of the armatures and breaking magnets in circuit with the motors. 10 claims.